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Machine learning in Geospatial analysis

Bùi Quang Thành
Nguyễn Quốc Huy
Phạm Vũ Đông
Nguyễn Hữu Duy

VNU University of Science

Sep 2021

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Agenda

- Remote sensing in supporting decision making
- Machine learning in LULC, natural hazards
  - Landuse / Landcover classification
  - Landslide detection
  - Susceptibility mapping (Flood, Landslide)
  - Early warning
- Discussions

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RS in supporting decision making

- Remote sensing technology to support sustainable urban development
- Meet the ever-increasing demand from city-based populations.
- Earth observation to support natural hazard analysis, urban zoning, population density mapping and planning the cities of the future, traffic management

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RS in supporting decision making

- Air pollution
- Biodiversity
- Urban and urbanizations
- Climate change and GHG emission
- Food securities
- Ocean research and ocean technology
- Water resources
- …….

- Natural hazards:
  - Landslide, flashflood susceptibility
  - Early warning

Urban management

LULC classification

Energy

….

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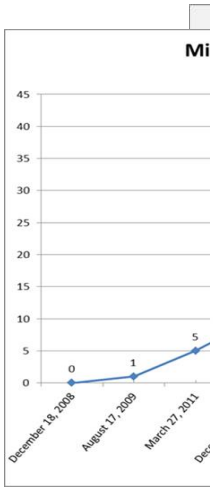
RS in supporting decision making



Digital earth/open

erentiated by year and by

esa

(2016)

5

RS in supporting decision making

Masterplan since 2006

Preliminary infrastructure

Micro satellites (optical, SAR, hyperspectral).

National research program on space technology

Applications

Education programs on space technology

Integrations

Government strategies to 2030, 2040

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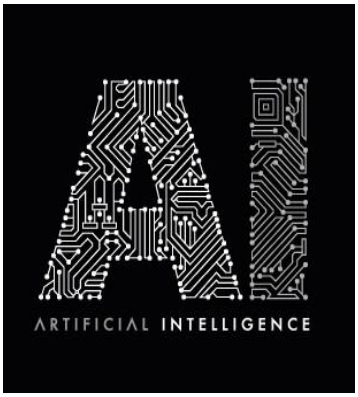
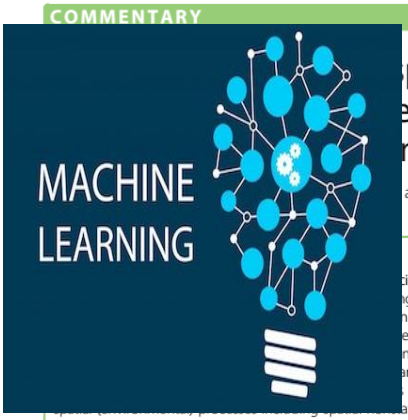
Machine learning in LULC, natural hazards





VoPham *et al. Environmental Health* (2018) 17:40
https://doi.org/10.1186/s12940-018-0386-x

Environmental Health

COMMENTARY Open Access

exposures across different geographic areas. The objectives of this commentary are to provide an overview of key concepts surrounding the evolving and interdisciplinary field of geoAI including spatial data science, machine learning, deep learning, and data mining; recent geoAI applications in research; and potential future directions for geoAI in environmental epidemiology.

Keywords: Geospatial artificial intelligence, geoAI, Spatial data science, Machine learning, Deep learning, Data mining, Remote sensing, Environmental epidemiology, Exposure modeling

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Machine learning in LULC, natural hazards

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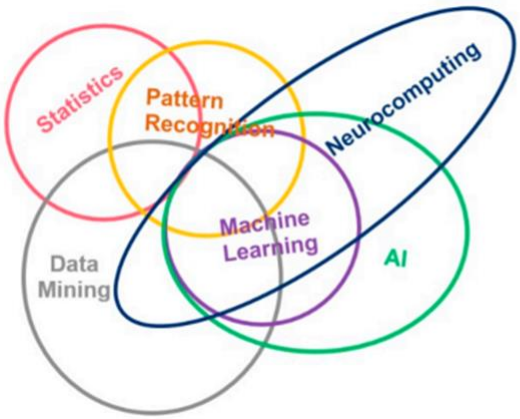
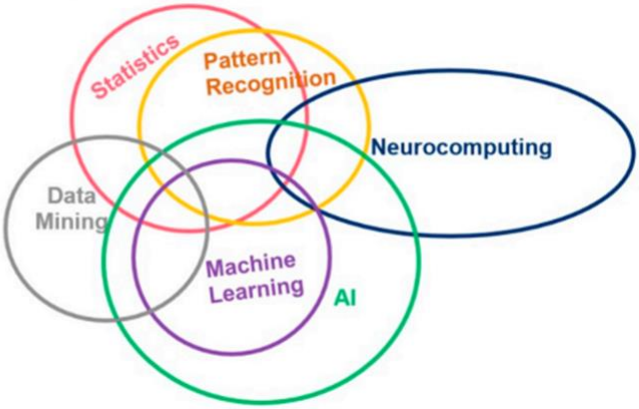
Machine learning in LULC, natural hazards





https://www.sciencedirect.com/science/article/abs/pii/S0012825220302713

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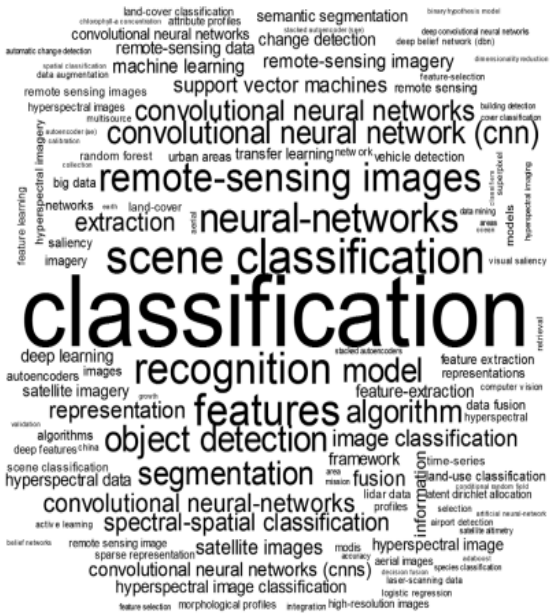
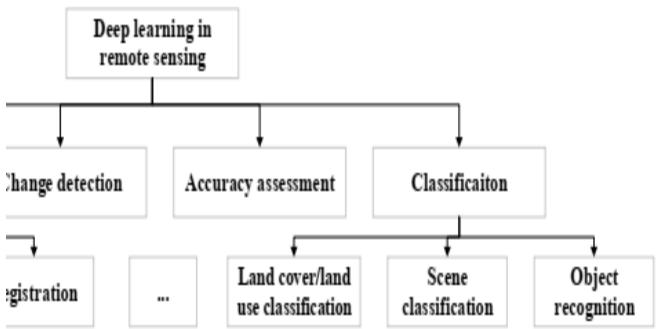
Landuse / Landcover classification





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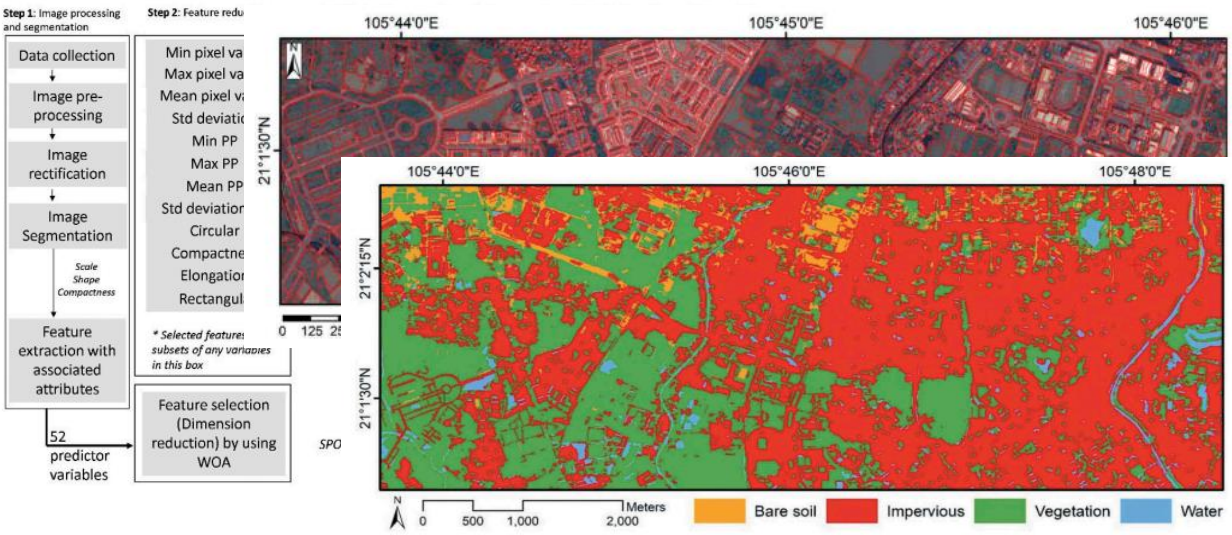
Landuse / Landcover classification



DOI: 10.1080/17538947.2018.1542039

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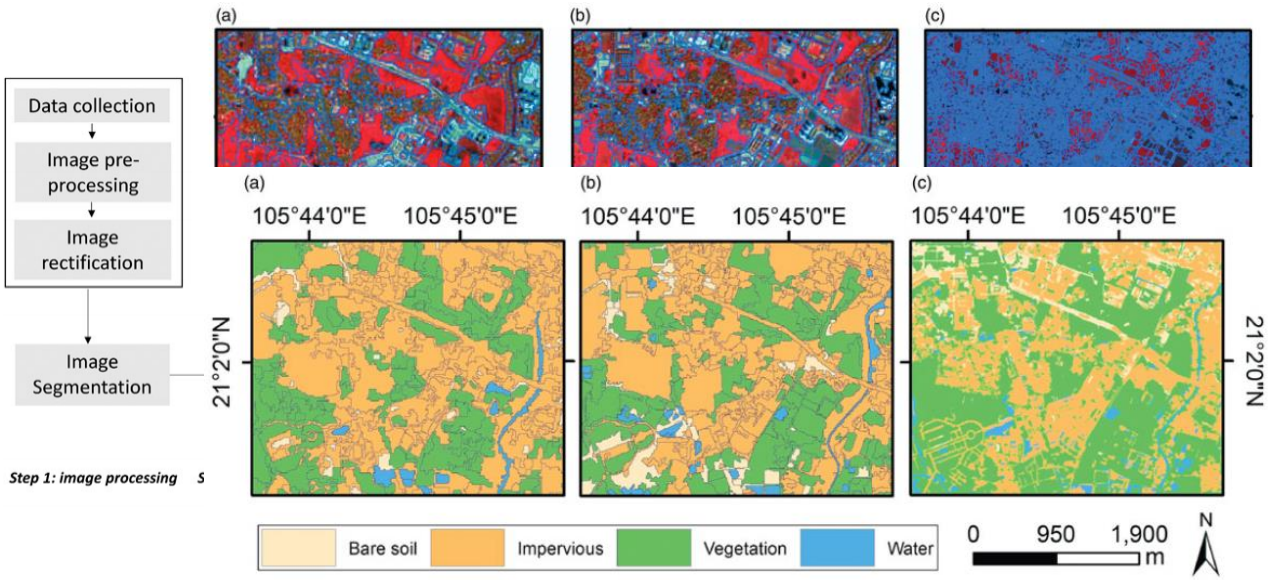
Landuse / Landcover classification



https://doi.org/10.1080/07038992.2019.1610369

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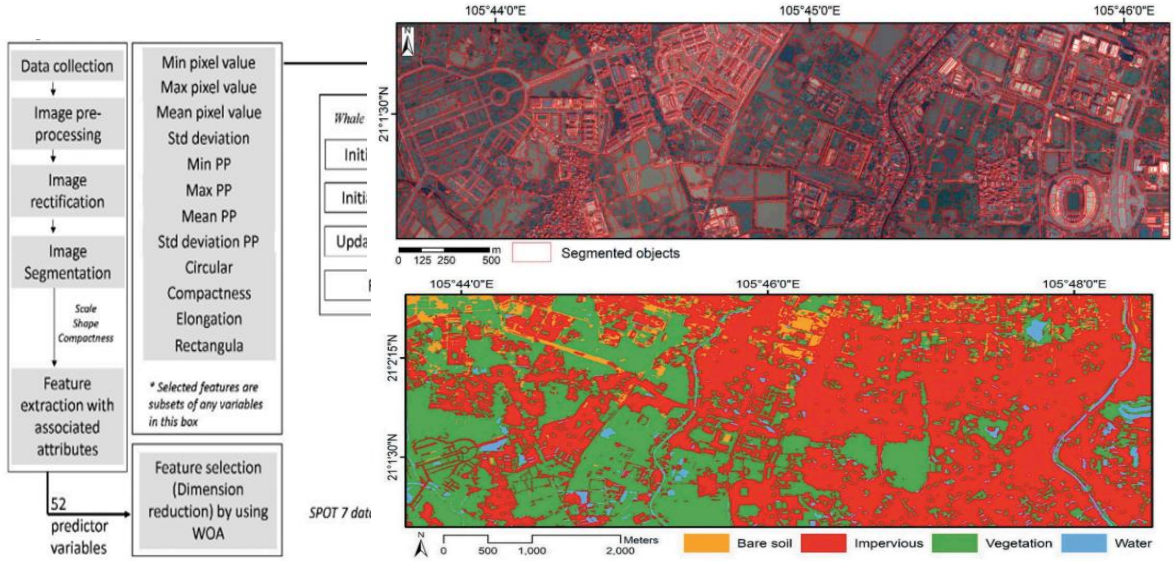
Landuse / Landcover classification



DOI: 10.1080/01431161.2019.1578000

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Landuse / Landcover classification

https://doi.org/10.3390/rs13142709

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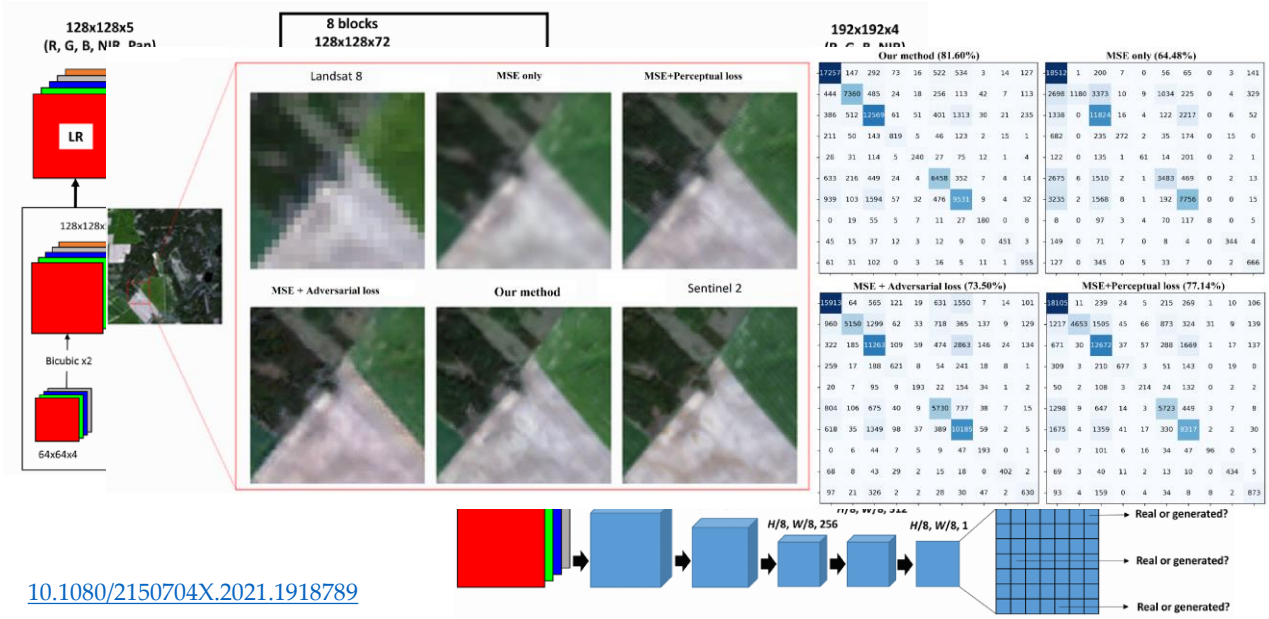
Machine learning in LULC, natural hazards



10.1080/2150704X.2021.1918789

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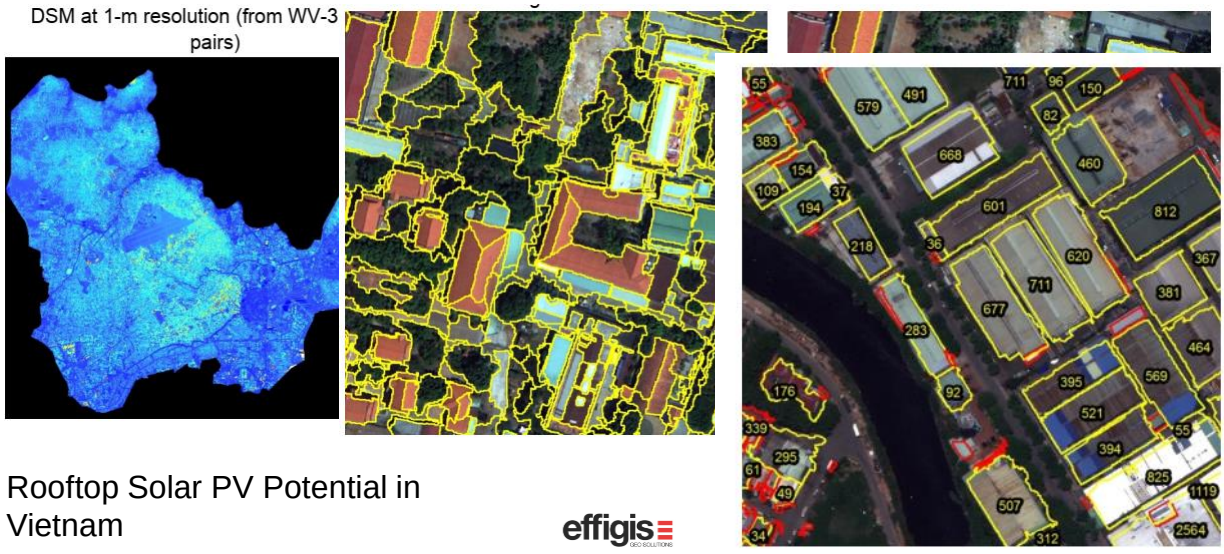
Machine learning in LULC, natural hazards



Rooftop Solar PV Potential in Vietnam

effigis GEO-SOLUTIONS

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Machine learning in natural hazards

Landslides

Floods

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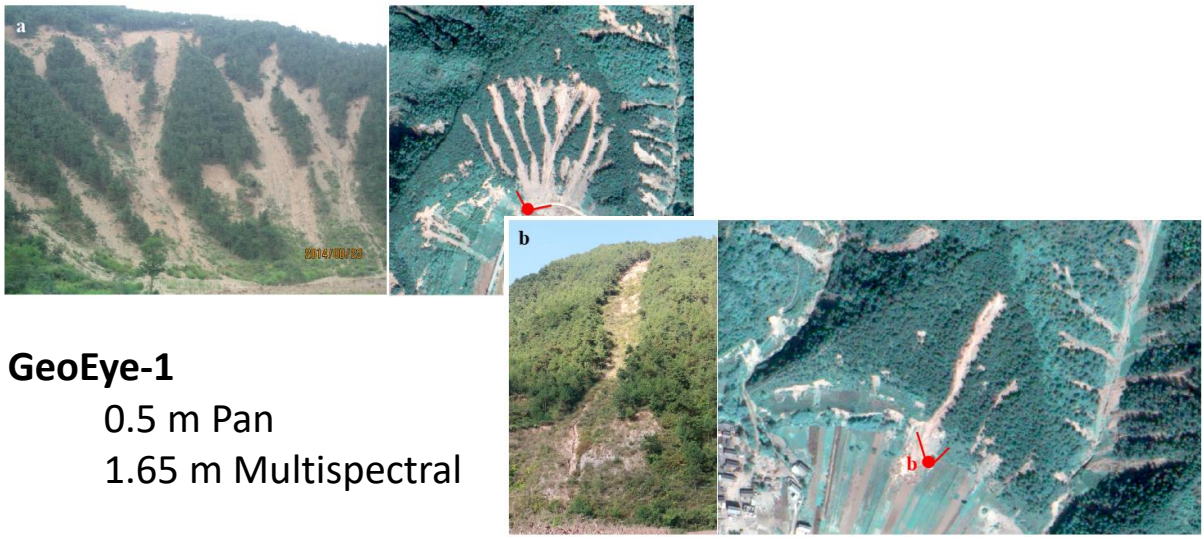
Landslide detection



GeoEye-1

0.5 m Pan

1.65 m Multispectral

doi:10.3390/rs12152487

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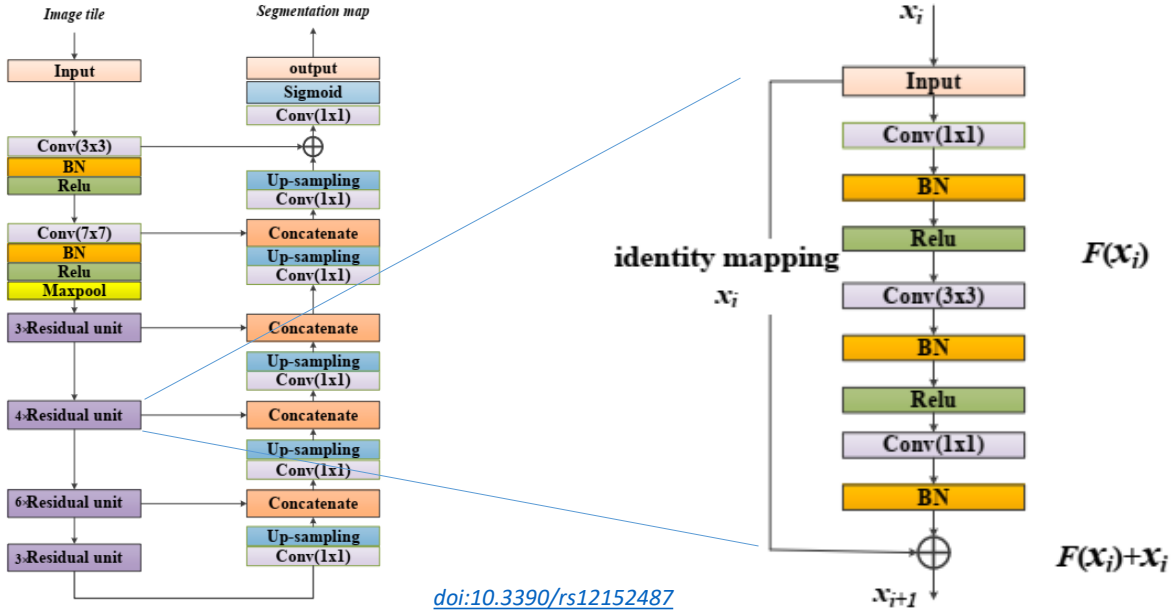
Landslide detection



doi:10.3390/rs12152487

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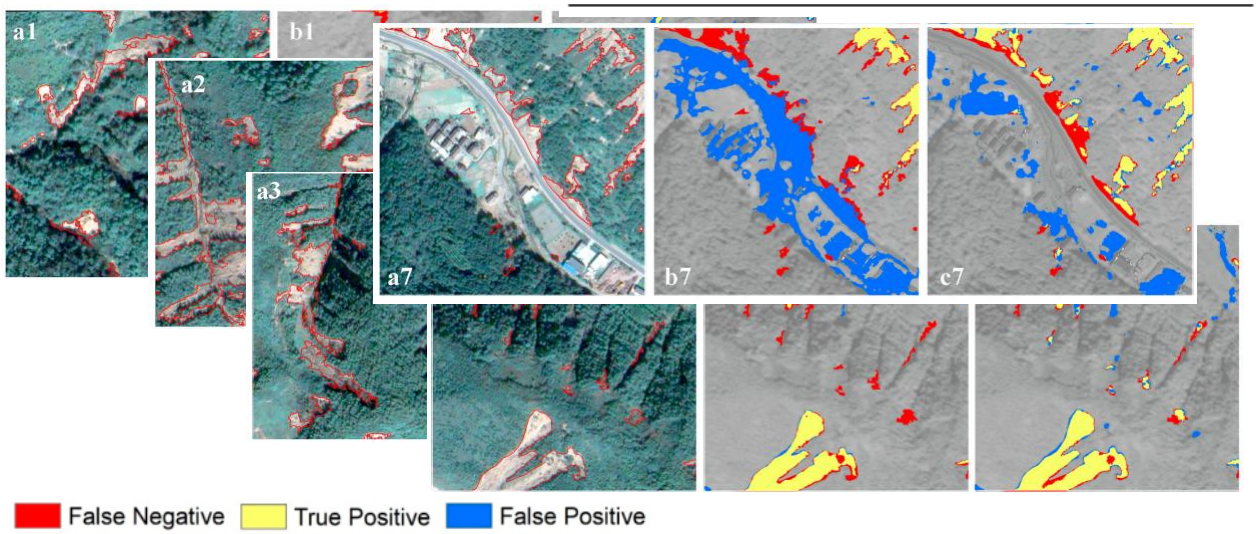
Landslide detection

doi:10.3390/rs12152487

Model	Precision (%)	Recall (%)	F1 (%)
U-Net	0.93	0.70	0.80
ResU-Net	0.96	0.83	0.89



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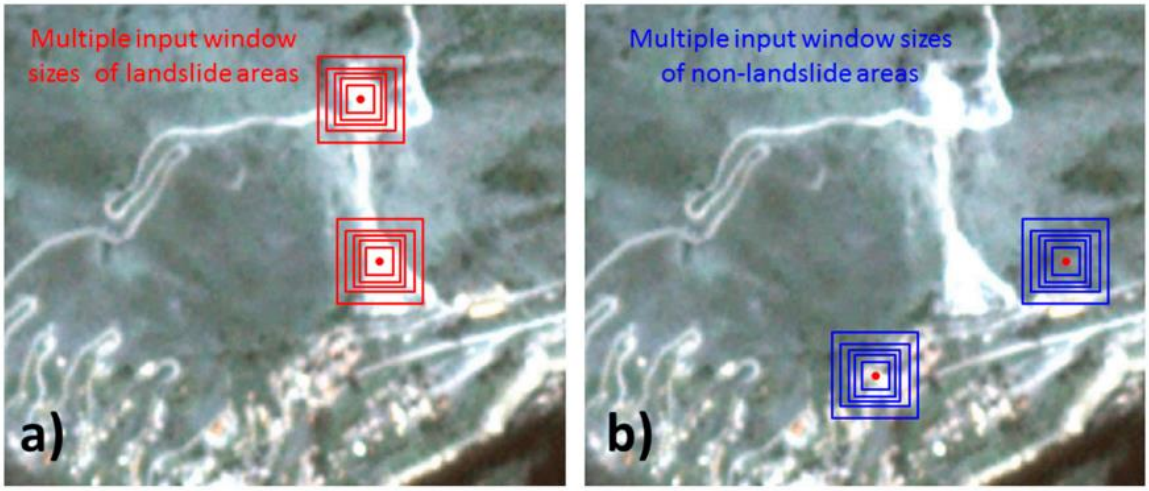
Landslide detection



https://doi.org/10.3390/rs11020196

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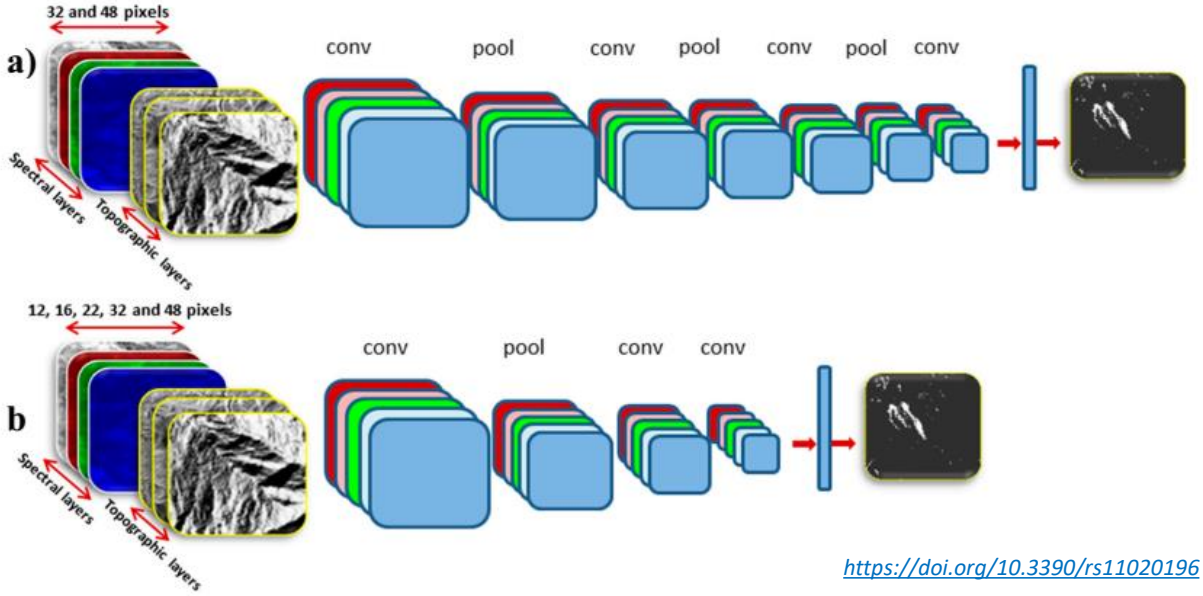
Landslide detection



https://doi.org/10.3390/rs11020196

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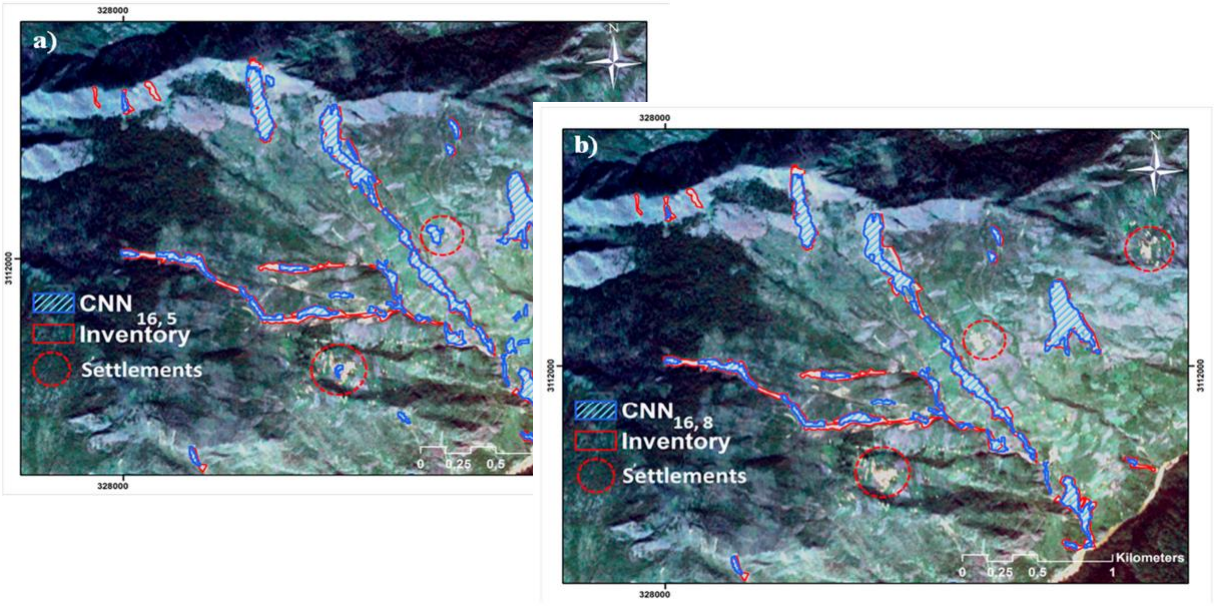
Landslide detection



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Landslide detection

- Landslide detectable using Deep learning
- High spatial resolution images (Worldview, GeoEye, UAV…)
- Spatial resolution upscaling

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Susceptibility mapping

- EES – Environmental Earth Science,
- GEM – Geomorphology,
- NAT – Natural Hazards,
- LAN – Landslides,
- ARA – Arabian Journal of Geosciences,
- NHE – Natural Hazard and Earth System Sciences,
- ENG – Engineering Geology,
- GNH – Geomatics Natural Hazard Risks,
- GEO – Geocarto International,
- CAT - Catena,
- JMS - Journal of Mountain Science,
- SCT – Science of Total Environment,
- REM – Remote Sensing,
- BOE – Bulletin of Engineering Geology and the Environment,
- ISP – ISPRS International Journal of Geo-Information,
- RSE – Remote Sensing of Environment,
- ASB – Applied Science,
- COM – Computer and Geosciences

https://www.sciencedirect.com/science/article/abs/pii/S0012825220302713

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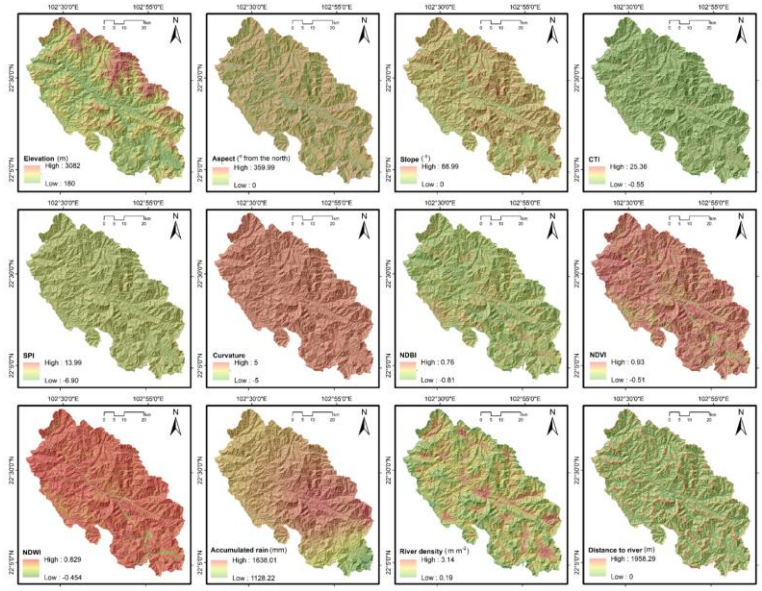
Susceptibility mapping



Input datasets

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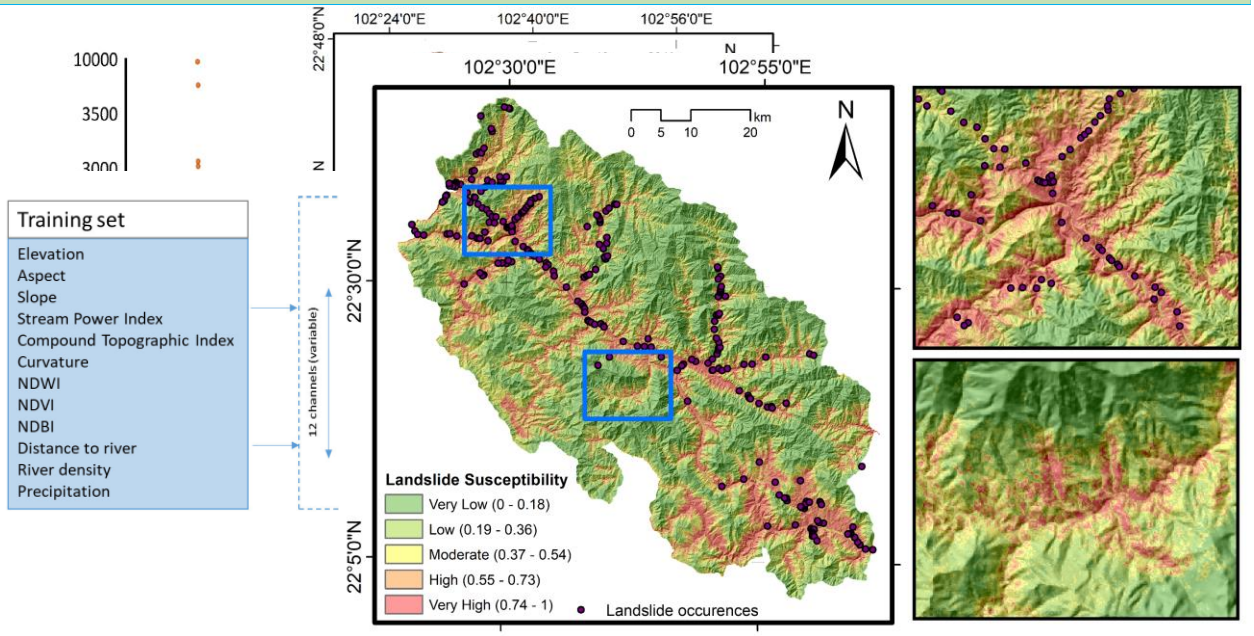
Susceptibility mapping



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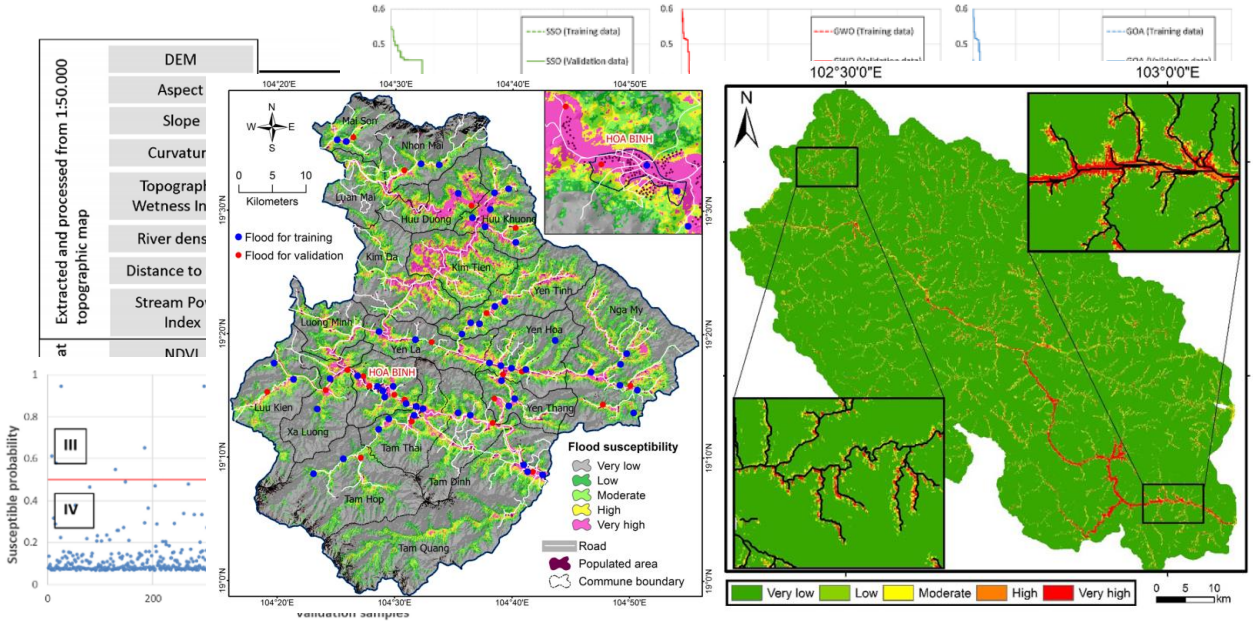
Susceptibility mapping



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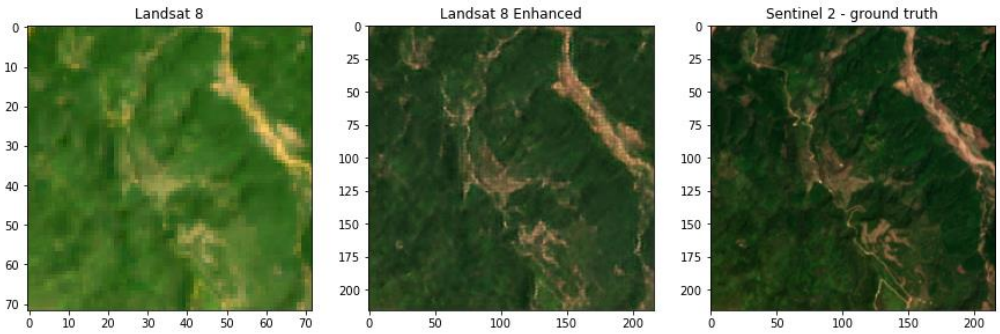
Susceptibility mapping

- Numerous studies
- Basic maps for hotspot studies (more detail in higher scale)
- Implemented with mid spatial resolution images (with Landsat, Sentinel)



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Early warning

Data-based early warning

- Weather forecast
- Rain thresholds potentially trigger landslides
- Field monitoring (temp, rain, movement sensor, underground water level…)
- Data from field surveys
- Landslide, Flood susceptible maps and hotspot zoom in

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Early warning

Achievement in Vietnam

- Multiple scale susceptible maps
- Technical profiles (soil structure, forest covers…) of several hotspots
- Landslide location database (point, polygon)

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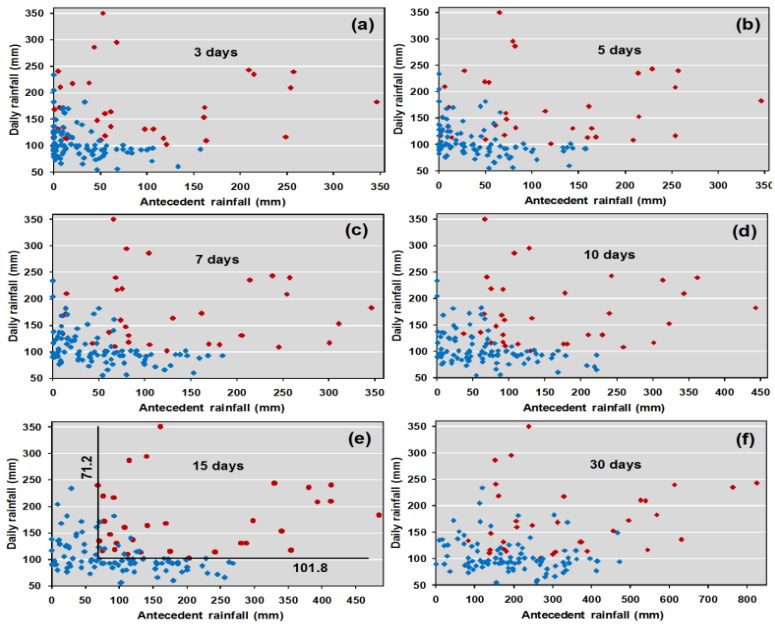
Early warning



Rain accumulation (7, 10, 15, 30 days) to define thresholds which trigger landslides

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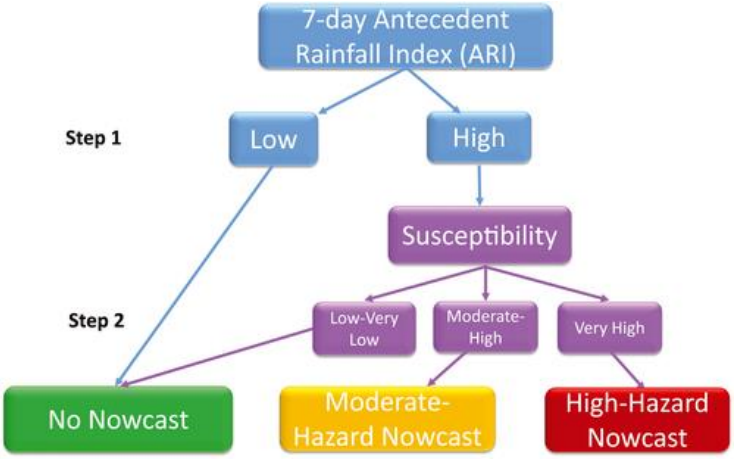
Early warning



$$ARI = \frac{\sum_{t=0}^{6} w_t P_t}{\sum_{t=0}^{6} w_t} \qquad w_t = \frac{1}{(t+1)^2}$$

P_t rain amount of day t , t=0 day of forecast, t=6 days before day of forecast

https://doi.org/10.1002/2017EF000715

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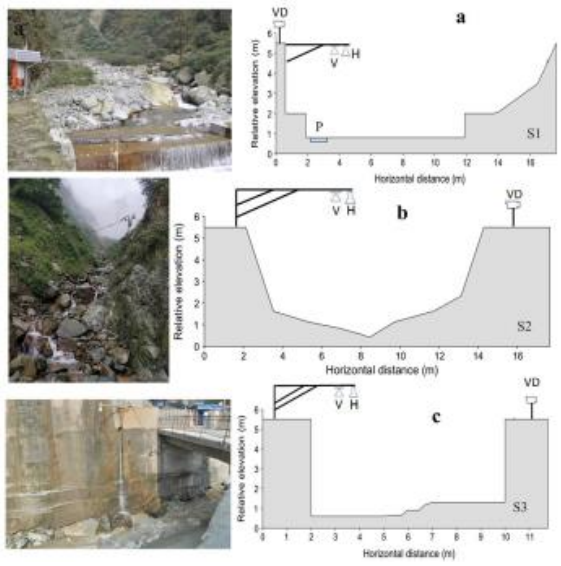
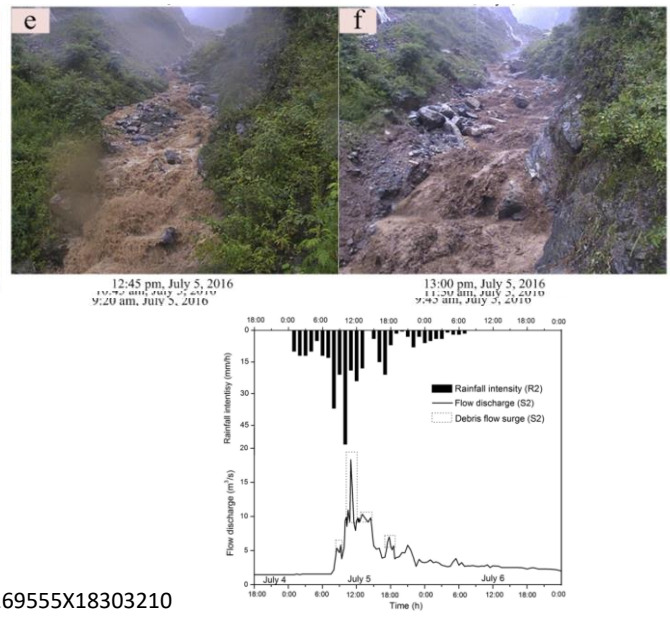
Early warning





https://www.sciencedirect.com/science/article/abs/pii/S0169555X18303210

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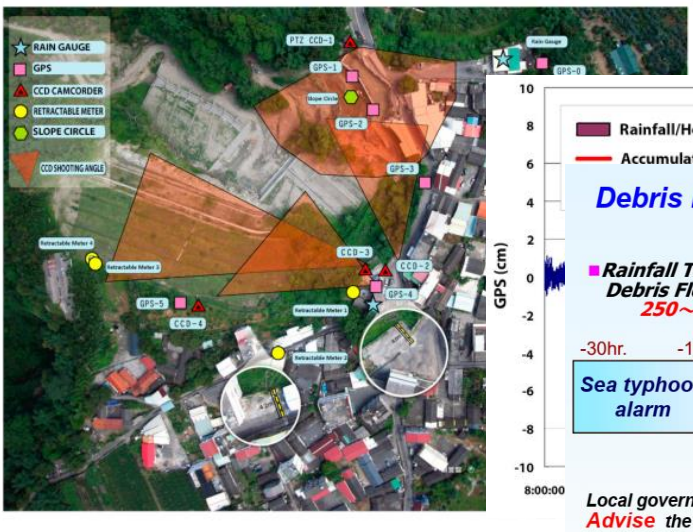
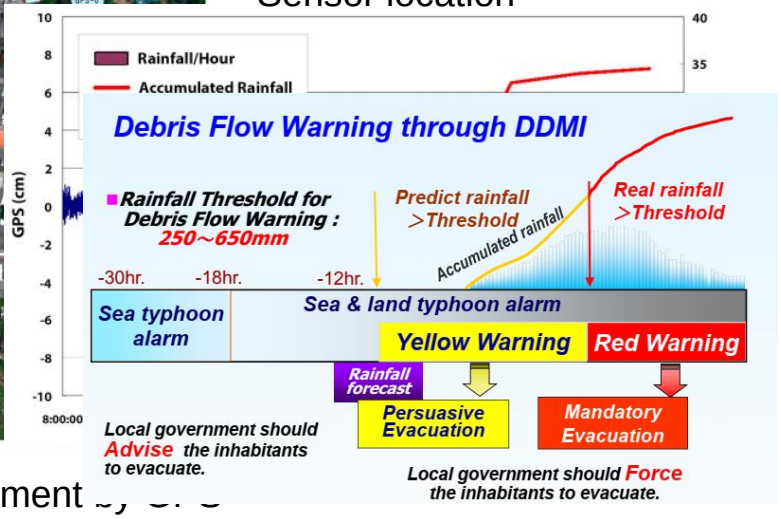
Early warning



Sensor location



Rain accumulation and movement by [illegible]

https://www.mdpi.com/2076-3417/10/19/6718

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Machine learning in **LULC, natural hazards**

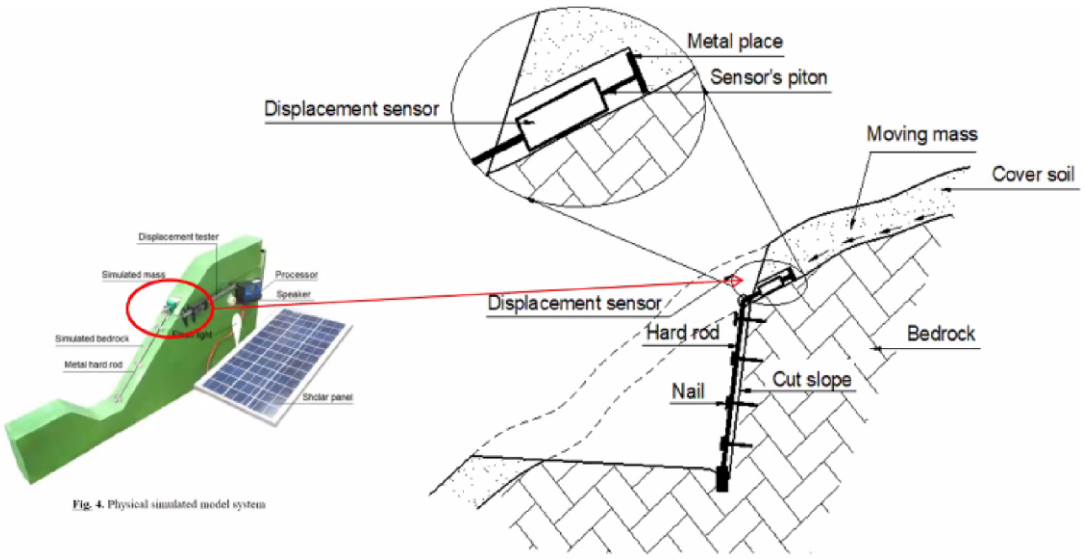

Fig. 4. Physical simulated model system

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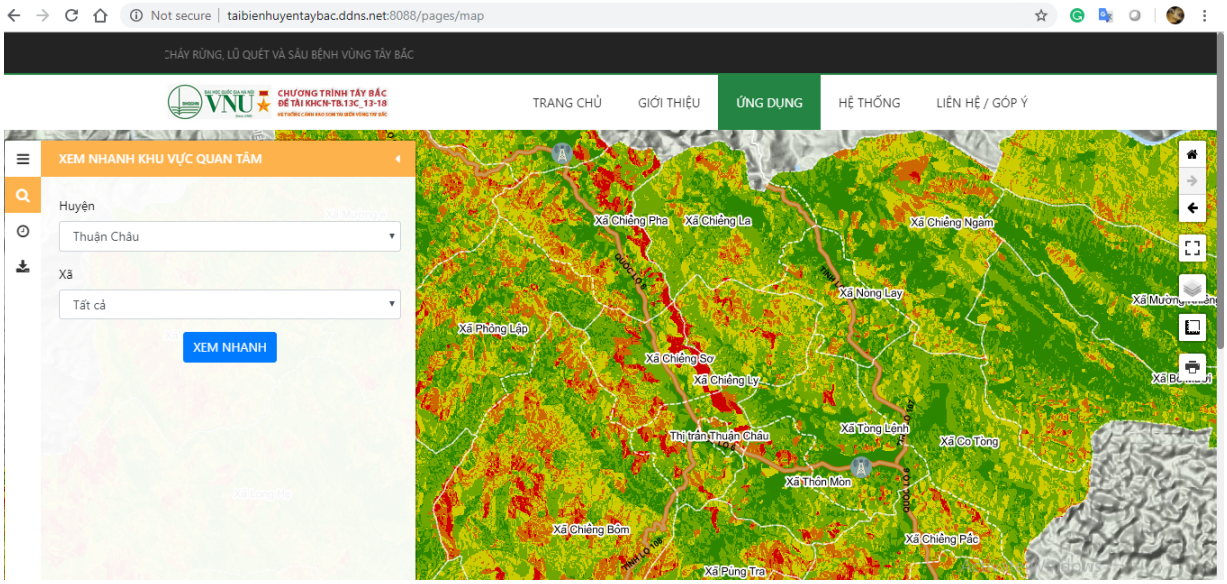
Early warning



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Machine learning in natural hazards

- Limited rain gauge stations
- Susceptible maps with mid spatial resolution (landslide areas normally several pixel size)
- Limited historic landslide data, weather data. Difficult to define thresholds triggering landslides (require large dataset)
- Limited profiles of landslide hotspots

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Machine learning in natural hazards

- Automatic detection of landslides using
  - Deep learning with high spatial resolution images
  - Collection of weather data when landslides occur
- Installation of sensor for early warning
- Early education of satellite data and their uses

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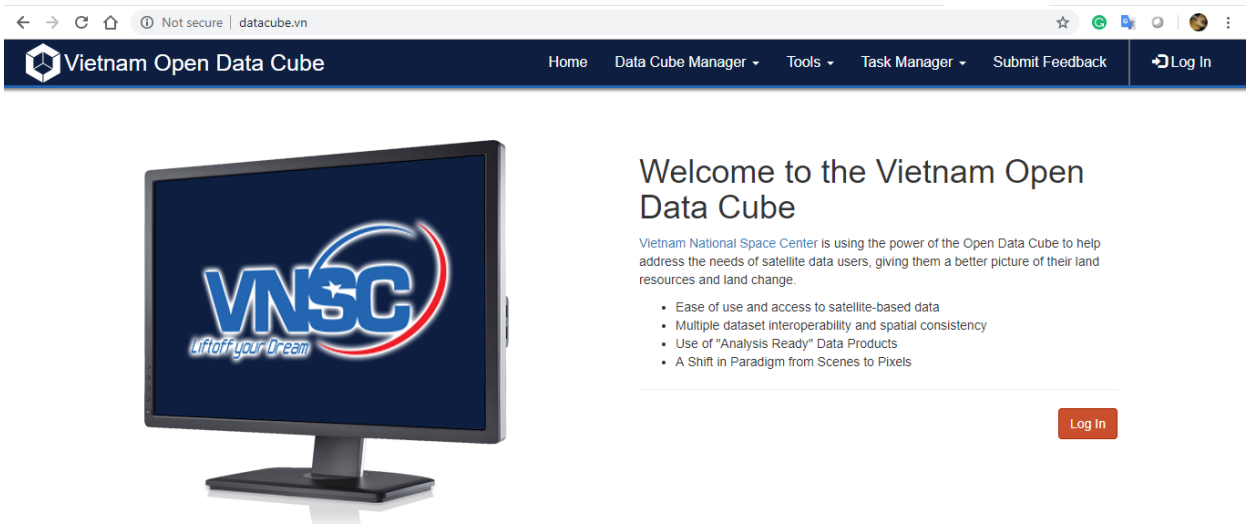
Data processing platform



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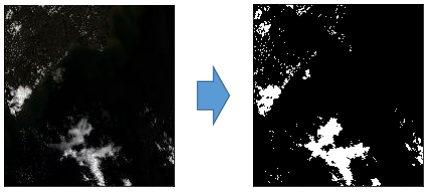
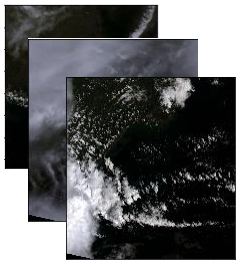
Data processing platform



The presence of cloud and its coverage level in an image could affect the integrity and the value of that image in most remote sensing applications that rely on optical satellite imagery

Landsat 8 images



ODC environment

- LANDSAT 8 data have been widely used for remote sensing applications
- Open Data Cube (ODC) environment allows big remote sensing data to be stored, managed and analyzed
- The identification of cloud cover helps researchers to select their desirable data for further analysis

→ An automated cloud segmentation method especially applied for multiple scale LANDSAT 8 images in ODC environment built on deep learning algorithm

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Discussions

- Data is not a big issue
- Never mind about softwares and computing platforms
- How to effectively uses data -> big concerns

and can be solved with good strategy and governance

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Many thanks !!!

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