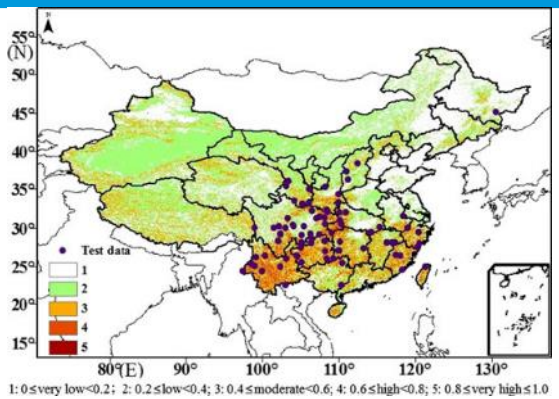


CEOS Landslide Pilot – China Study Site: Research Progress

Zeng-Guang Zhou

zgzhou@aoe.ac.cn

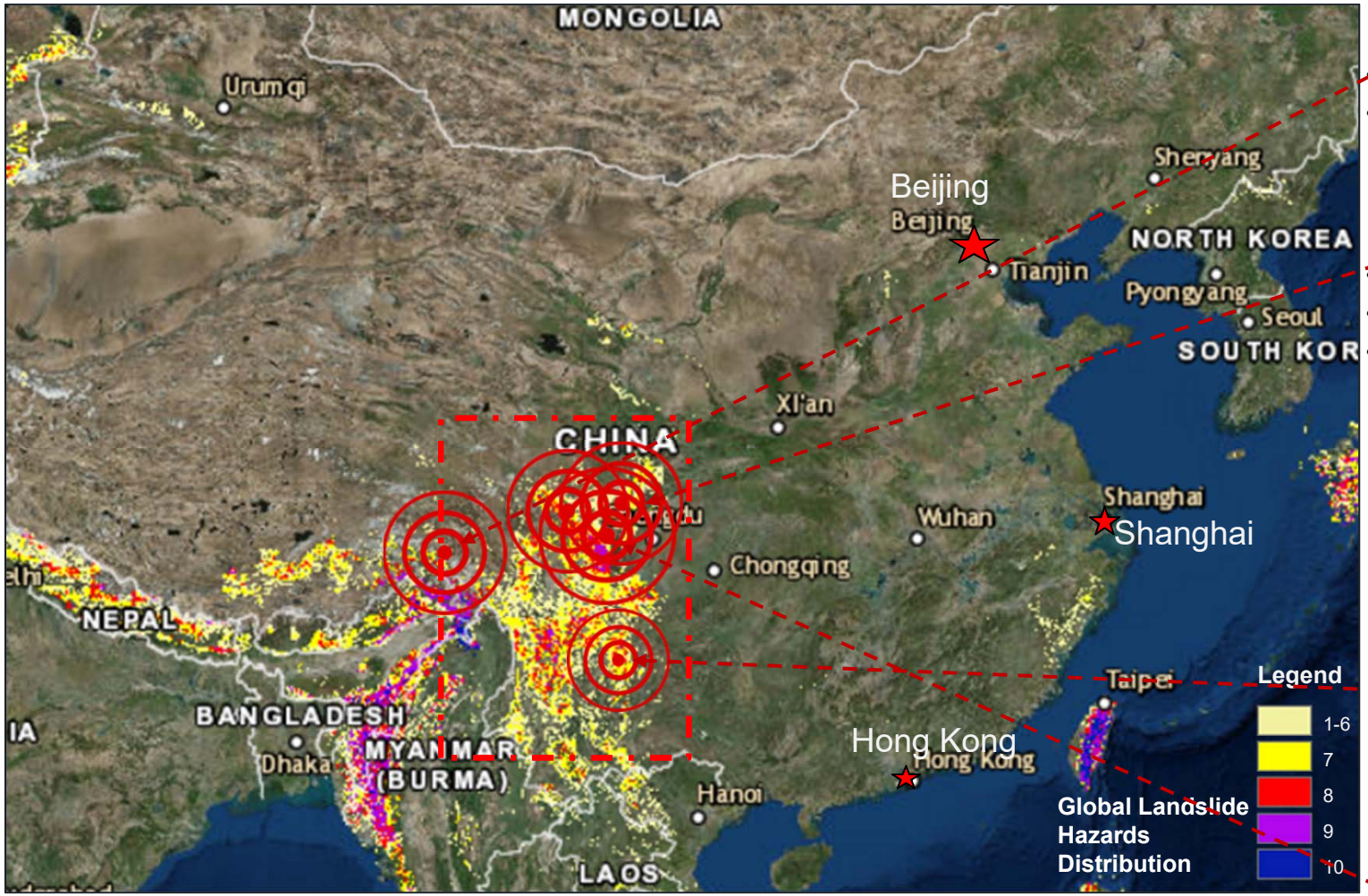
Key Laboratory of Quantitative Remote Sensing Information Technology, Academy of Opto-Electronics (AOE), Chinese Academy of Sciences (CAS)

Napoli, 5-7 September, 2018

Region of Interest

Current Study Region: SW China

Big earthquakes & Landslides occur every year.



Ms6.9 Earthquake

- **Linzhi, Tiebet, Nov. 18, 2017**
- **Lots of landslides along Highway**

Ms7.0 Earthquake

- **Jiuzhaigou, Aug. 8, 2017**
- **No. of landslides: unknown**
- 25 deaths, 6 missing.

Ms6.5 Earthquake

- **Ludian, August 3, 2014**
- **1,000+ big landslides**
- 617 deaths, 112 missing.

Ms7.0 Earthquake

- **Lushan, April 20, 2013**
- **703 landslides in towns**
- 196 deaths, 21 missing.

Ms8.0 Earthquake

- **Wenchuan, May 12, 2008**
- **48,000 landslides**
- **70,000 fatalities** (20,000 by landslides)

Global Landslide Hazards Distribution

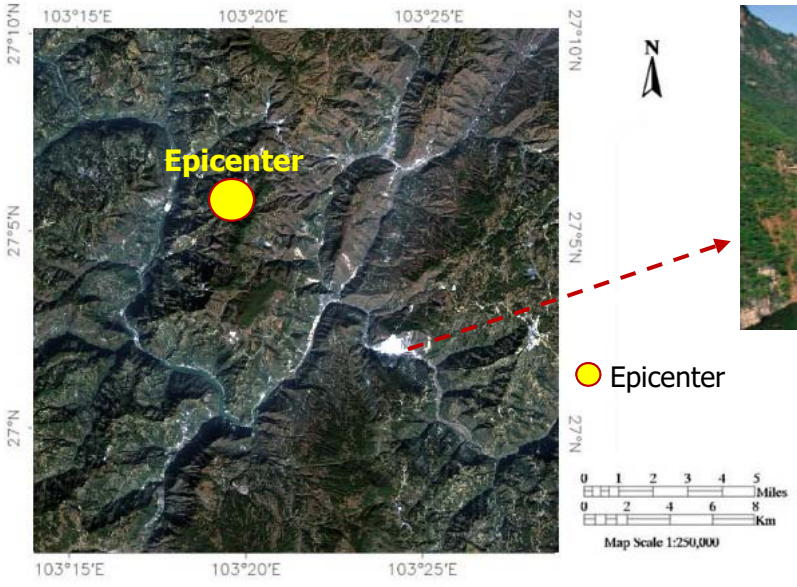
https://databasin.org/datasets/b5c842f4b248464593a7673f5ad7f10f

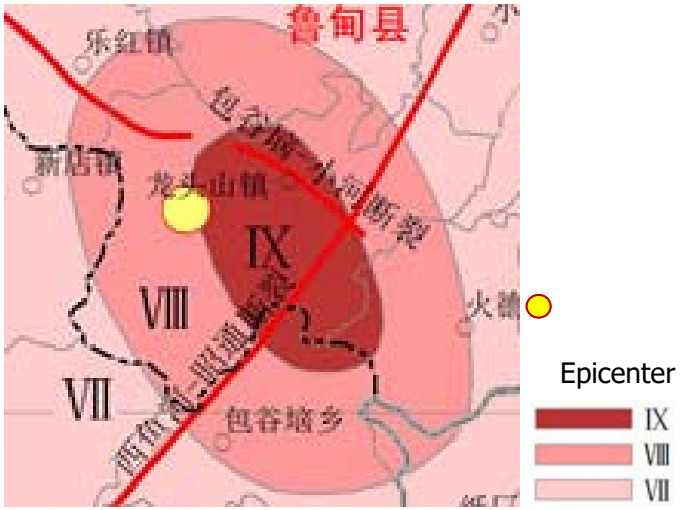
Credits: Center for Hazards and Risk Research (CHRR); Center for International Earth Science Information Network (CIESIN), Columbia University; Norwegian Geotechnical Institute (NGI)

Current Study Site (Ludian in SW China) and Data (optical Images)

Zone of Ms6.5 Ludian Earthquake

August 3rd , 2014





Landslides & Barrier Lake

(water level 58m, storage 50 million m³)

Flood discharged

(Hydropower station and town uncover)

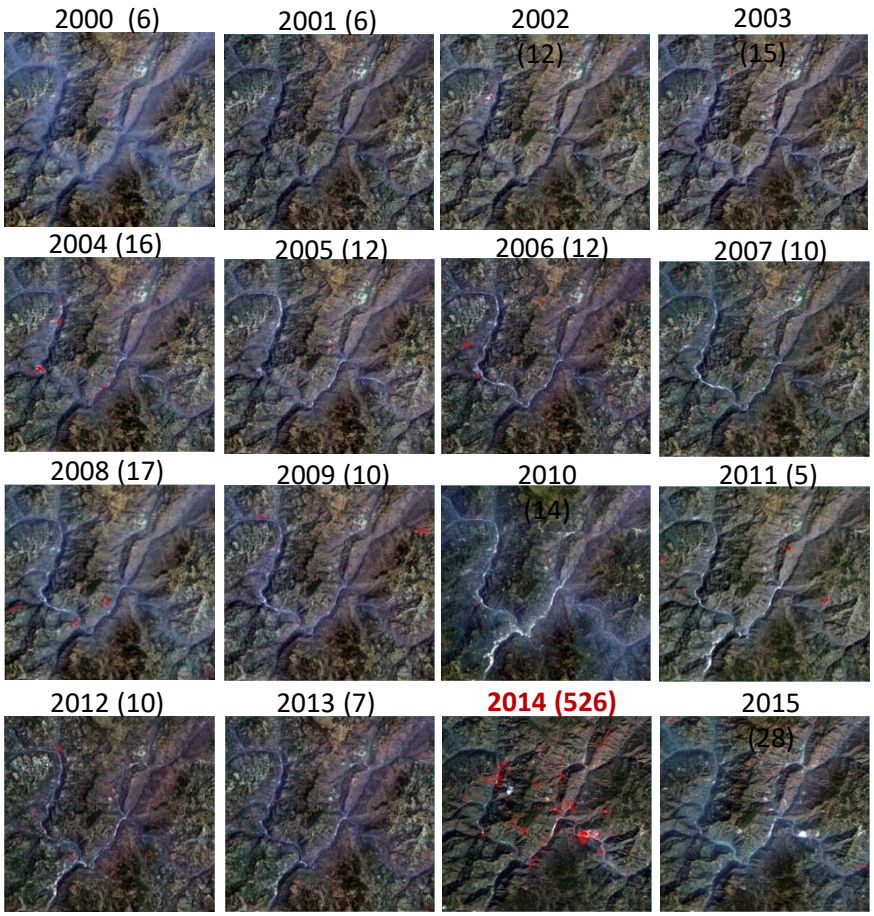
Flood inundated 10+ towns and 30 km² croplands

Optical Images Time Series

(332 images, 8-30m Res., 2000-2016)

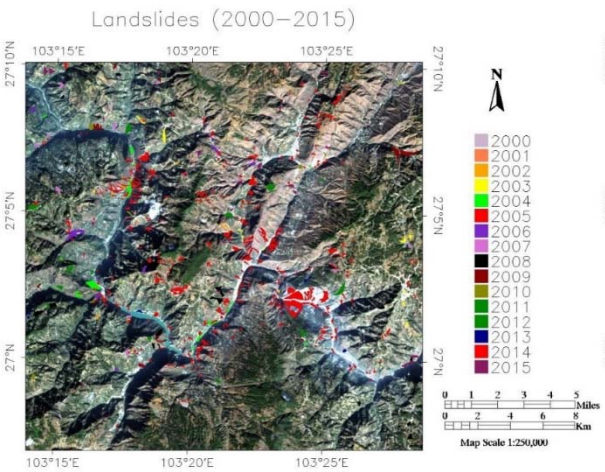
Satellite Sensor	Period	Images count.	Revisit period	Spatial Res.	Country
Landsat TM/ETM+/OLI	2000~	**172**	16 d	15/30 m	USA
GaoFen-1 CCD	2013~	**68**	4 d	2/8/16m	China
HuanJing-1 CCD	2008~	**92**	4 d	30 m	China

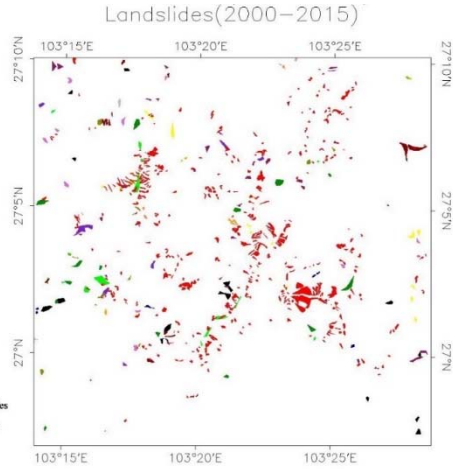
Preliminary Results – Visually Interpreted Landslides (2000-2015)

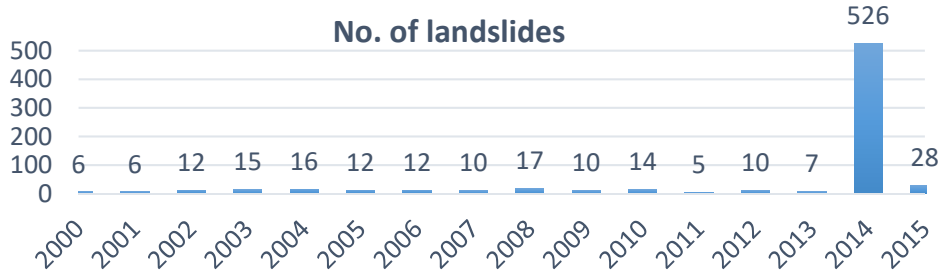


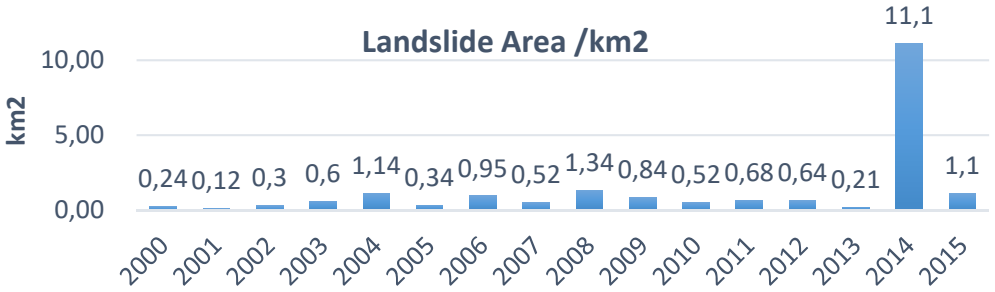
Year (Landslides)

- Landslides > 90*120 m^2









- Landslides occurred every year due to geologic activity and precipitation.
- A large amount of huge landslides were induced by the earthquake in 2014

Method developing 1: Detect historical landslides in optical image time series

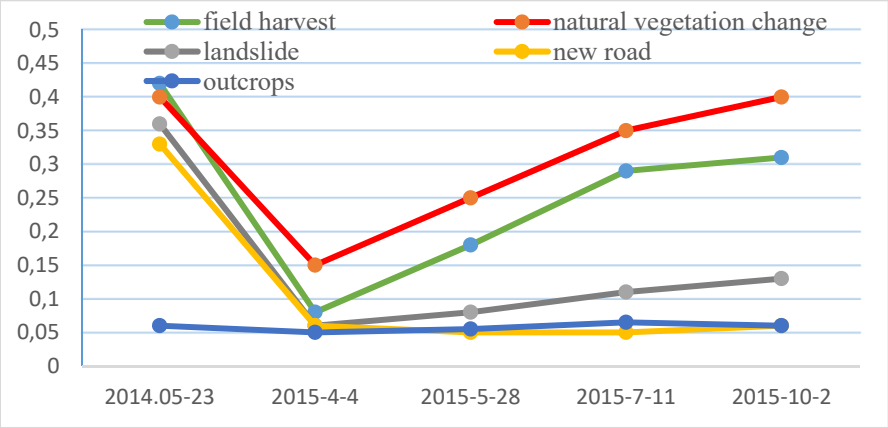
Landsat-8 OLI, 22/04/2015 | Visually Interpreted Landslides | Automatically Detected Landslides

Results:

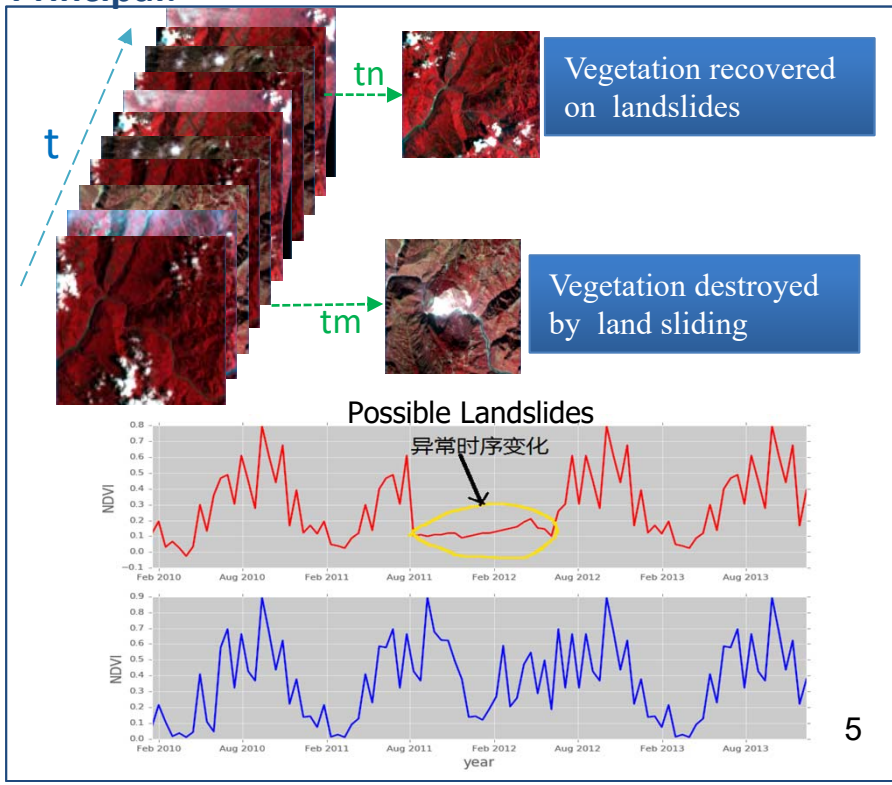
Detect	Interpreted	TP	FN	Producer Accuracy	User Accuracy
1372	1017	872	145	63.56 %	**83.28 %**

Different Revegetaion Rates to differentiate

Crops harvest, Seasonal change, Landslide, Outcrops and Road



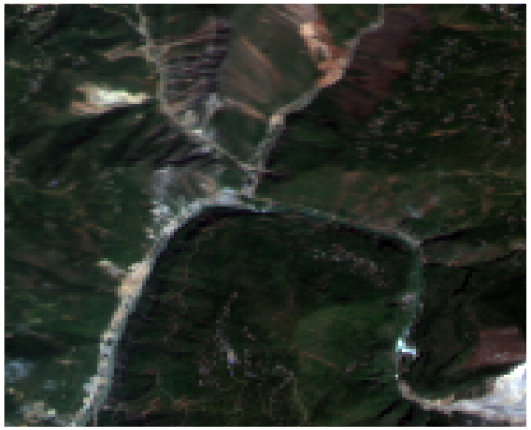
Principal:



Method developing 2: Detect new landslides in new available optical images

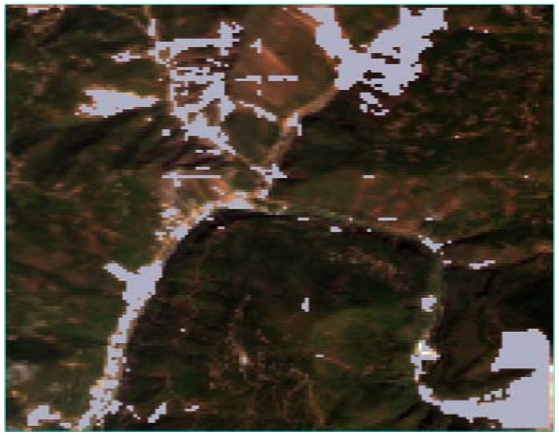
New available optical image

Gaofen-1 CCD, 11/09/2014



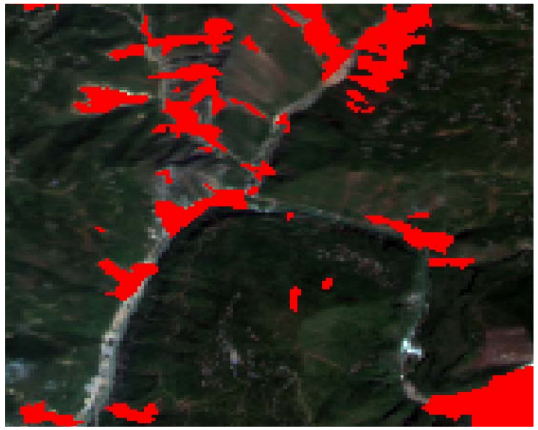
Automatically Detected Landslides

in new image using LSTM and SVM



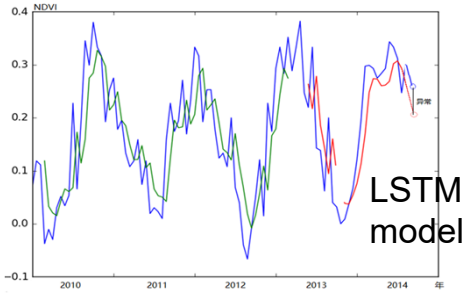
Visually Interpreted Landslides

in new image

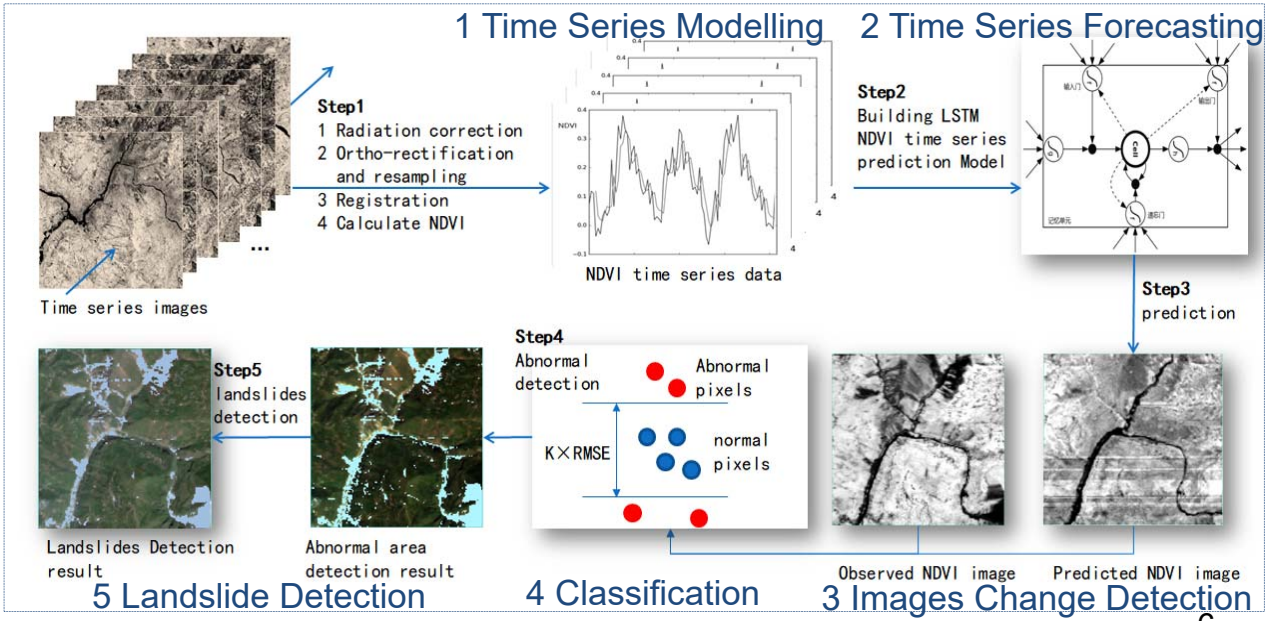


Features and models:

Temporal + Spectral + Spatial Features



Method:



Zeng-Guang Zhou, et al., "A Landslides Detection Method Based on LSTM Time Series Prediction Model," in preparation.

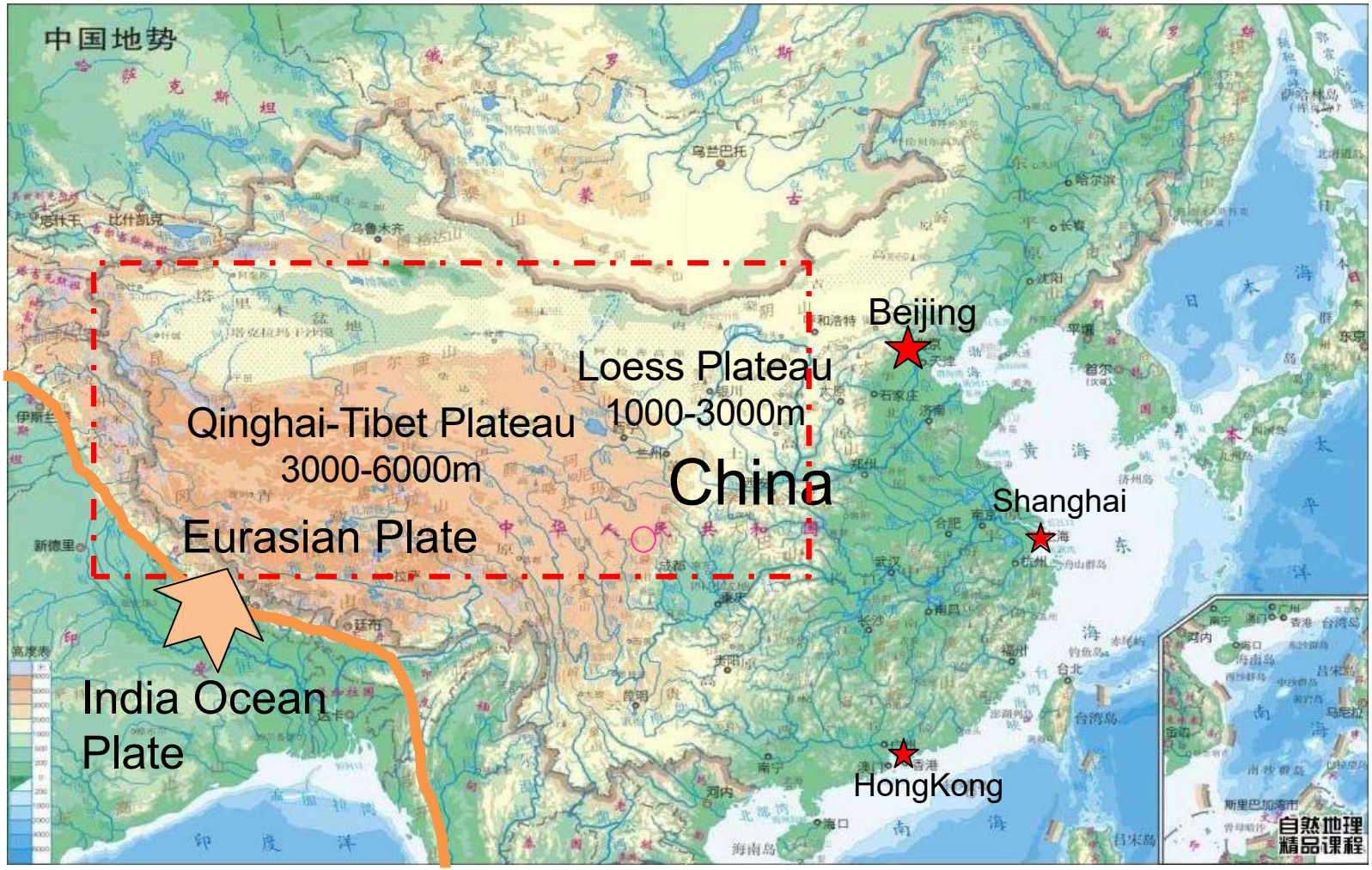
Extended Study Region – West China

West China: Geologically active, Cold and Arid Regions

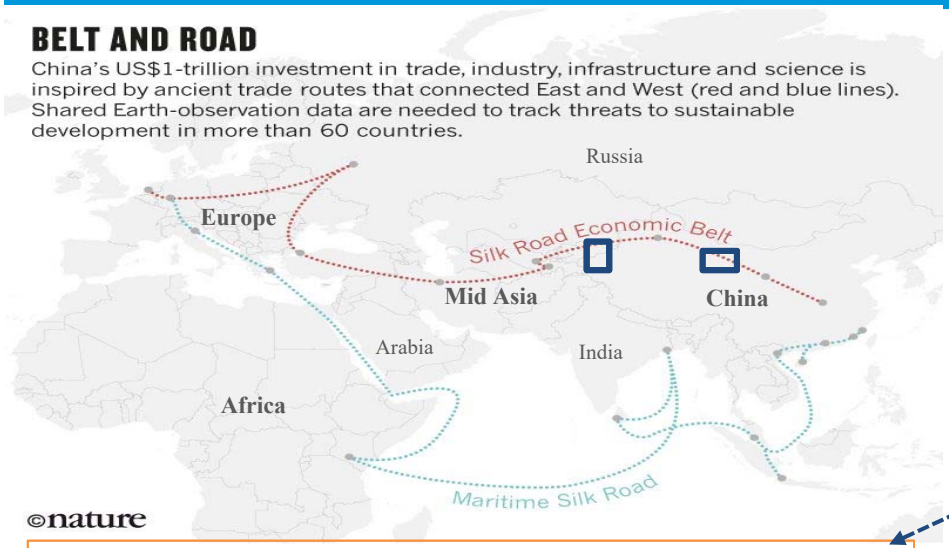
High altitude and/or Little rainfall :

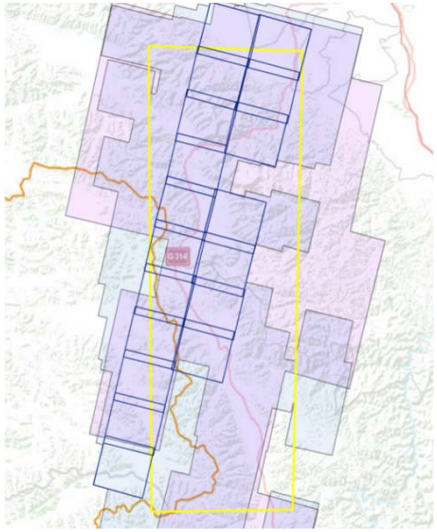
Elevation: 1000-3000m & 3000-6000m

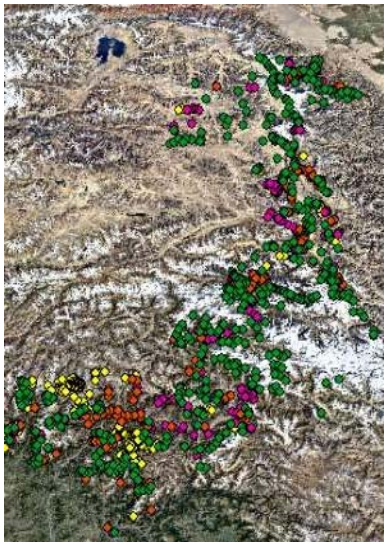
Precipitation: ≤ 200mm/year



Preliminary Results – Geohazards in Cold & Arid Regions in West China





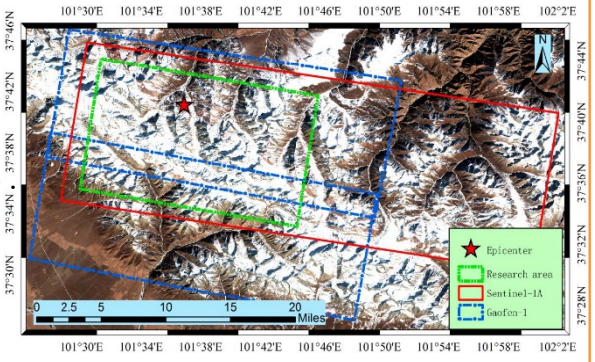


Optical images:
Chinese Gaofen-1: 2/8 m
Chinese Gaofen-2: 1/4 m

Visually interpreted:
Landslide & collapse: 237
Debris flow: 491
Gravel-sliding slop: 212

Zeng-Guang Zhou, Li-Qin Han, et al.,

Sentinel 2A image shows area of Ms 6.4 Menyuan Earthquake on 21/01/2016.



12 large possible geo-hazards detected by Sentinel-1A.
bg: Chinese Gaofen-1 optical images.

Q. Huang, et al., "Geo-Hazard Detection and Monitoring Using SAR and Optical Images in a Snow-Covered Area: The Menyuan (China) Test Site," Geo-Information, 2017.

Field investigations in Cold & Arid Regions of West-China

Along National Highway on Qinghai-Tibet Plateau

Elev.: ≈4000m Prec: ≈70mm/a

(in July 2018)

Landslide & Gravel-sliding Slope

LiDAR scanning

Team Climbing

Landslide & Debris flow

LiDAR scanning

Yaks passing by

Along National Highway on Loess Plateau

Elev.: ≈2000m Prec: ≈200mm/a

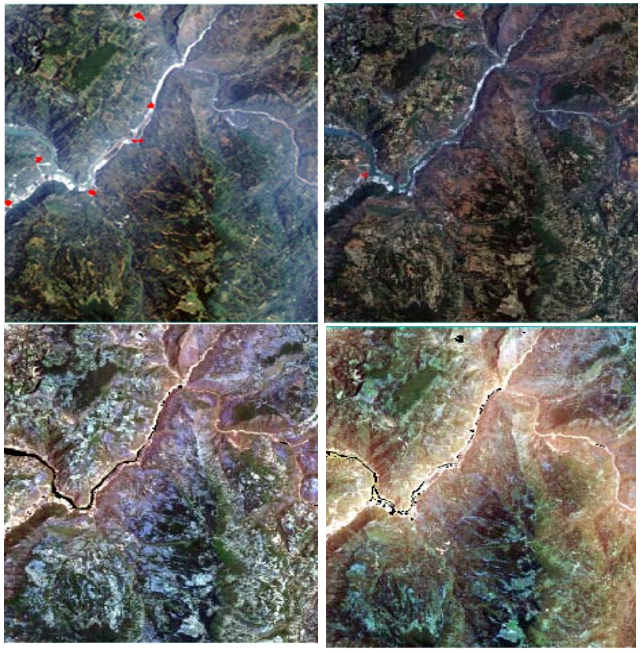
(in March 2018)

Loess Landslides

What's next for China Study Site

– **For densely vegetated region in Southwest China:**

Improve the methods to detect landslides on a quarterly to monthly basis using optical images time series.



Intra-annual landslides detection in vegetation-covered area

– **For non- or sparsely vegetated region in West China :**

Explore methods to recognize landslides in cold and arid areas using radar & optical images.

Landslides detection in Cold & Arid region

CEOS Landslide Pilot – China Study Site

Thanks