DISASTER MANAGEMENT APPLICATION USING NEXT GENERATION L-BAND SAR SATELLITE SYSTEM

TAKUMI SATO

GEOSPATIAL ENGINEER

KOKUSAI KOGYO CO., LTD.

INTRODUCTION:
WORLD DISASTER TREND

Principal Disaster:

Flood, Windstorm, Drought, Epidemic, Famine, Earthquake

Table. The frequency of recorded natural disaster occurrences globally between 1900 and 2006

	1900-2006	Number of Disasters	(%)	Number killed	(%)	Total affected	(%)
Water-related Disasters	Flood	3,050	29.8	6,899,095	18.5	3,027,693,701	48.3
	Windstorm	2,758	26.9	10,008,806	3.2	752,843,507	12.0
	Drought	836	8.2	1,208,806	26.8	2,239,624,826	35.7
	Slides	508	5.0	55,980	0.2	10,206,768	0.2
	Wave/Surge	52	0.5	295,813	0.8	2,596,663	0.0
Non Water-related Disasters	Epidemic	1,035	10.1	9,528,995	25.6	40,156,618	0.6
	Wild Fire	312	3.0	2,710	0.0	4,019,267	0.1
	Extreme Temperature	322	3.1	69,138	0.2	11,466,747	0.2
	Volcano	193	1.9	95,917	0.3	4,907,517	0.1
	Insect Infection	83	0.8	0	0.0	2,200	0.0
	Famine	76	0.7	7,158,229	19.2	70,996,301	1.1
	Earthquake	1,025	10.0	1,963,172	5.3	104,038,367	1.7
	Total	**10,250**	**100.0**	**37,286,332**	**100.0**	**6,268,551,482**	**100.0**

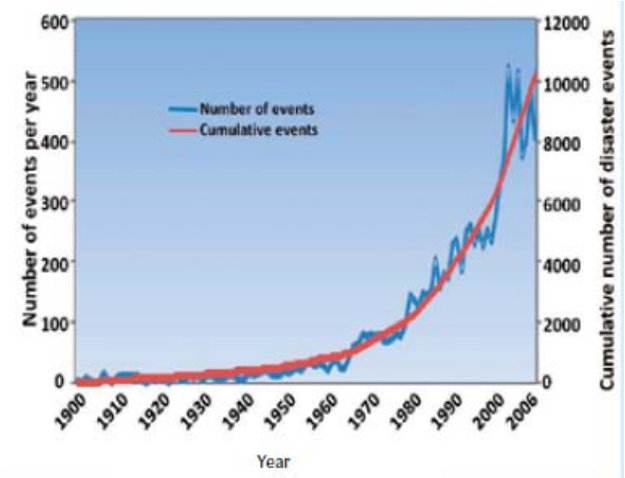


Fig. Natural disaster events recorded globally between 1900 and 2006

Global Trends in Water-Related Disasters:
an insight for policymakers / UNESCO, ICHARM
http://unesdoc.unesco.org/images/0018/001817/181793E.pdf

REQUIREMENTS

What we want to know ASAP:

- Distinguish catastrophic area
- Find fatal zone
- Find emergency evacuation zone

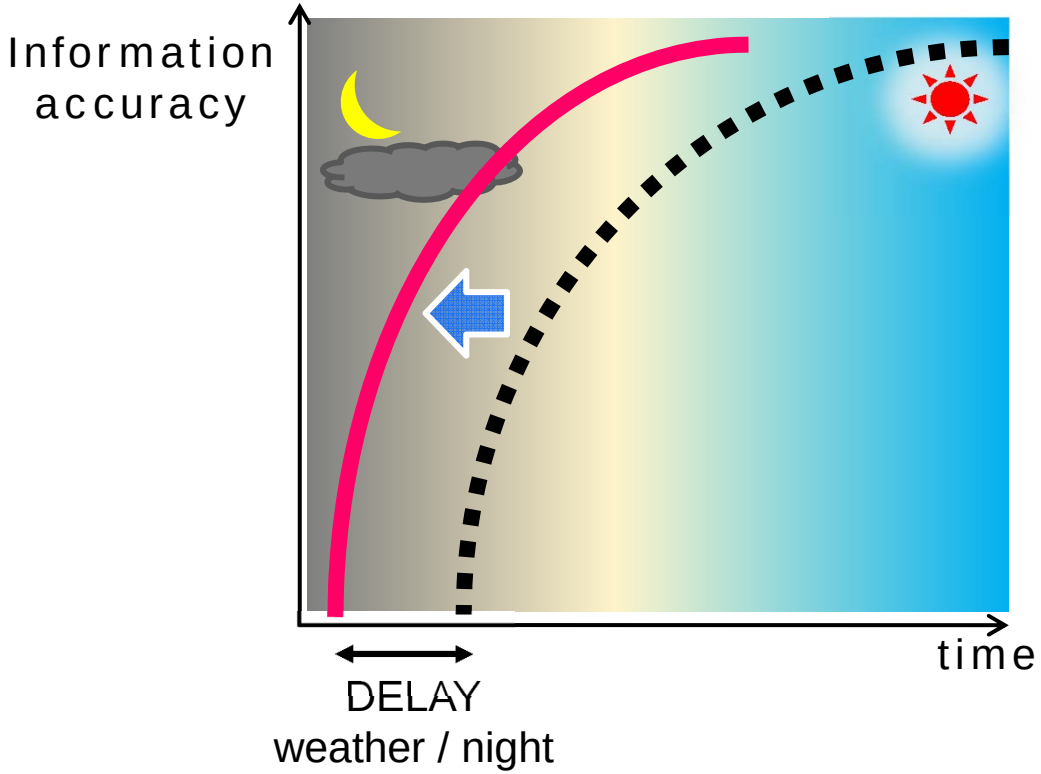
Functions and Conditions:

- Independent with weather condition and day or night time
- Wide range and high resolution observation to grasp the scale and disaster type
- Insensible change detection for disaster prediction

SAR EFFECTIVENESS FOR DISASTER RESPONSE

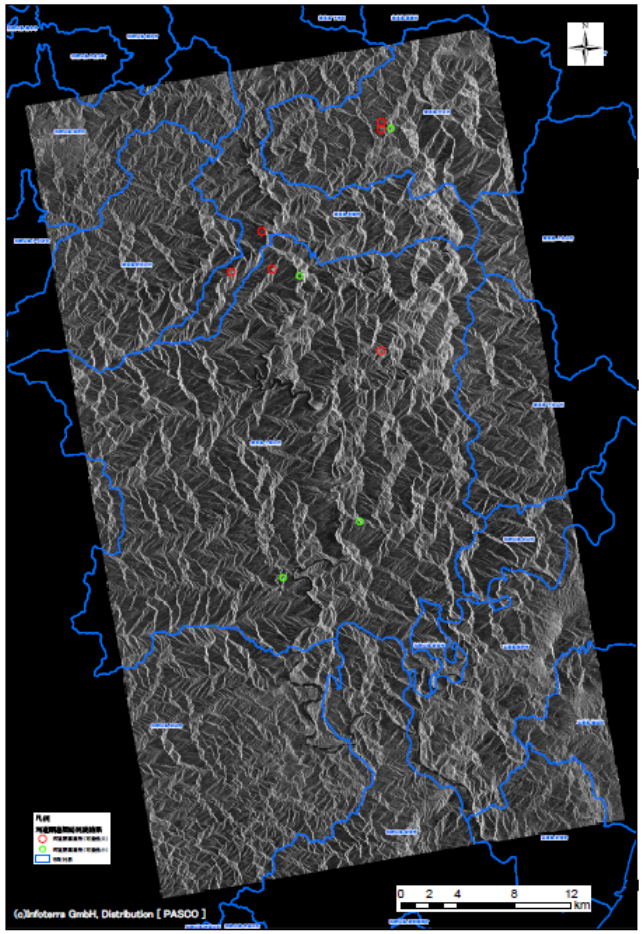
Faster initial response

→Increasing survival probability



EXAMPLE (JAPAN)

Five landslide dams found under heavy cloud



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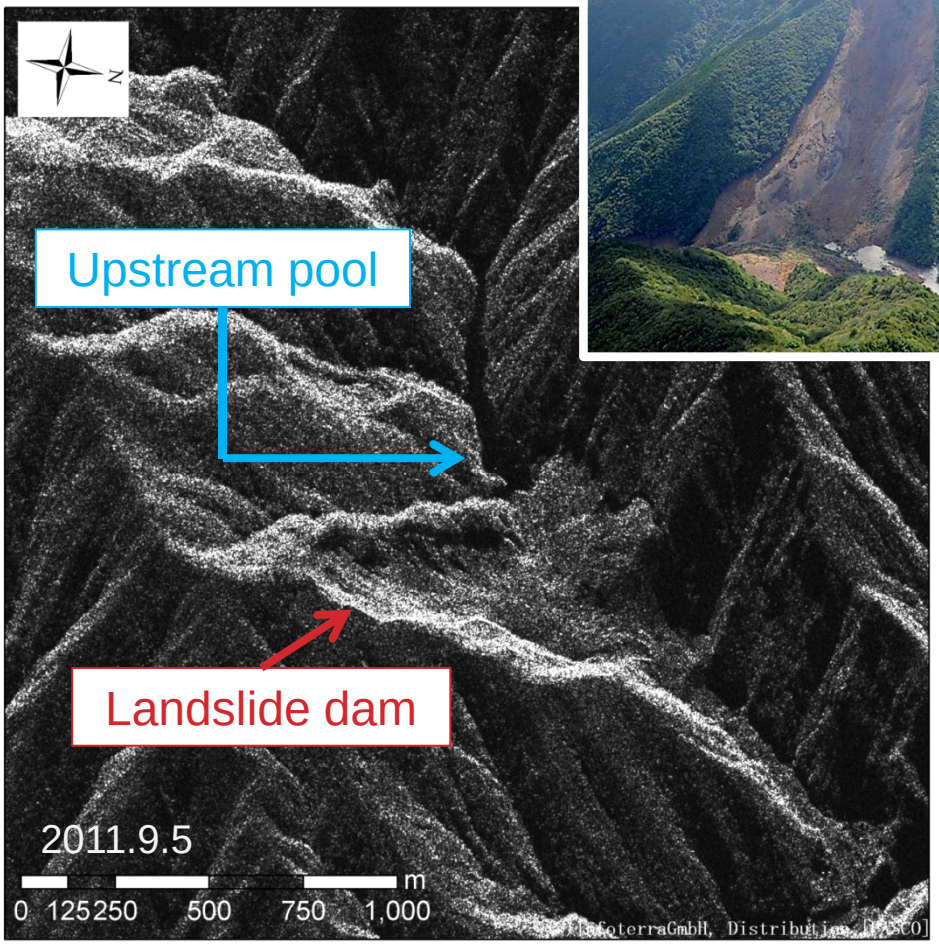

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CASE APPLICATIONS OF NATURAL DISASTER

FLOOD

Observation target: Flooded area (temporal change)

Causes: Heavy rain, bank collapse, glacial collapse

Swath: 350km (50km JPN)

Data type: Amplitude image

Analysis method: Image subtraction (before and after)

Ground resolution: 10m

Timeline: In a day (in a few hours JPN), continuous observation

TSUNAMI

Observation target: Water region (temporal change)

Causes: Earthquake

Swath: 350km

Data type: Amplitude image

Analysis method: Image subtraction (before and after)

Ground resolution: 10m

Timeline: In a few hours (1st), continuous observation

LANDSLIDE / DEBRIS FLOW

Observation target: All damaged region

Causes: Earthquake, Heavy rain and Snow melting

Swath: > 50km

Data type: Full Polarization

Analysis method: Dual Pol. Image, HH-VV correlation

Ground resolution: 3m

Timeline: in a couple of days

Photo: National Institute for Land and Infrastrucuture Management; North Kyushu Heavy Rainfall Disaster

LANDSLIDE DAM

Observation target: huge landslide dam (>100m width)

Possibility for secondary disaster at down stream region:

Severe debris flow caused by landslide dam collapse

Timeline: in a few hours

Photo: National Institute for Land and Infrastrucuture Management; Kuridaira landslide dam

STRUCTURE DAMAGE

Observation target: Buildings, Roads, Bridges

(Change detect three-dimensional structures)

Causes: Earthquake, Tsunami, Flood

Swath: > 50km

Data type: Full Polarization

Analysis method: Layer stack, DInSAR

Ground resolution: 1 or 3m (High resolution preferred)

Timeline: in a few days

OIL SPILL

Observation target: sea surface (oil distribution)

Causes: marine accident

Swath: 350km

Data type: Full Polarization

Analysis method: Image subtraction (before and after)

Ground resolution: 10m

Timeline: in a few days

FOREST FIRE

Observation target: Burned region

Causes: Lightning, accident, spontaneous combustion

Swath: >50km

Data type: Full Polarization

Analysis method: DInSAR

Ground resolution: 10m

Timeline: in a few days

VOLCANIC ERUPTION

Observation target: Volcanic ash distribution

(for volcanic ash flow)

Causes: Volcanic activity

Swath: >50km

Data type: Full Polarization

Analysis method: DInSAR,

Ground resolution: 10m

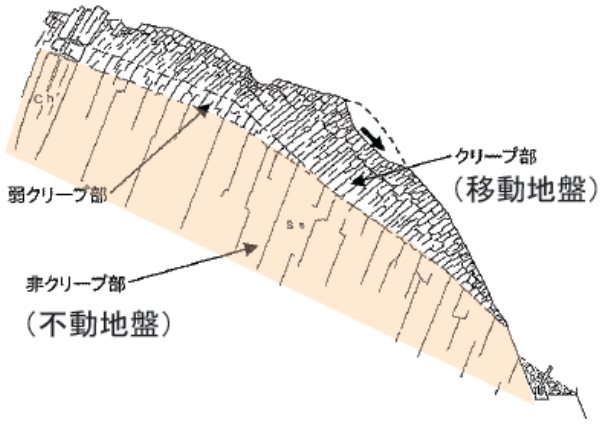
Timeline: in a few days

Image by JAXA (ALOS); Shinmoe-dake eruption

L-BAND DINSAR MONITORING FOR DISASTER PREDICTION

SLOW-SPEED LANDSLIDE EXTRACTION

“deep-seated slope failure” caused at bedrock creeping or slow landslide area.



Terrain features: KNOWN

Exigency: UNKNOWN

 # Most of the area covered with deep forest.

SYSTEM REQUIREMENTS FOR DISASTER MANAGEMENT

ORBIT TIMING: DAWN-DUSK OR NOON-MIDNIGHT

Noon-midnight

- Temporal complement (Other satellites have dawn-dusk orbit)
- The only tool for large area monitoring in midnight
- Difference of InSAR quality between Ascending and Descending

Dawn-dusk (Sun-synchronous Orbits)

- Durable system
  - stable power source, solar paddle without running gear
- Stable data acquisition for InSAR
  - Ionospheric disturbance and plasma bubble appear in midnight
- Same observation timing with other satellites

SATELLITE FORMATION: TANDEM (FF) OR SYMMETRY

Tandem

- Get DEM product in short time
- Revisit time longer

Symmetry

- Short revisit time
- Short temporal base-line InSAR
    - InSAR-based Time Series Analysis is feasible
- Need to wait for DEM product

CONCLUSION

High resolution, short revisit, and wide swath SAR system:
PERFECT tool for disaster application!

Wide swath (-350km) and fixed angle observation:
Extract damaged or hazardous area automatically

Short revisit time:
Rapid observe makes Rapid evacuation order

L-band InSAR:
Detect change under FOREST region continuously

Thank you!