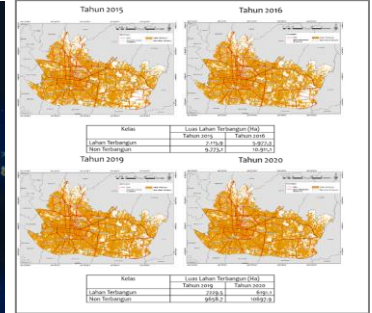
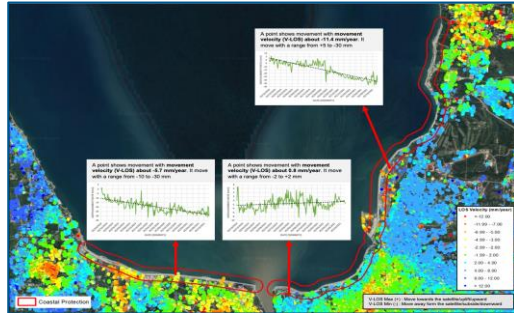




Sign in

rokhis google scholar - Search

Muhammad Rokhis Khomarudin -

https://scholar.google.com/citations?user=RA5YWWQAAAAJ&hl=en

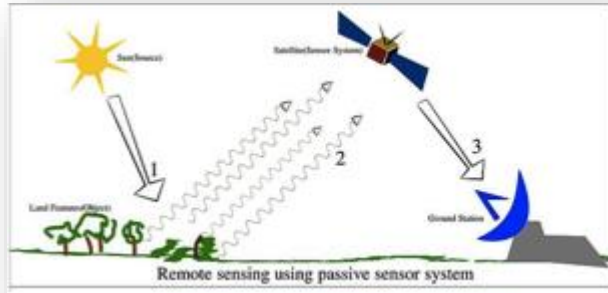
Materi Presentasi

- Sekilas tentang penginderaan jauh dan perkembangannya
- Prinsip deteksi kestabilan bangunan dan Kerentanan terhadap bencana (Metode dan Interpretasi)
 - Metode umum pengolahan data satelit
 - Landsubsidence/movement
 - Delineasi bangunan dari citra satelit
 - Deteksi material bangunan dari satelit
- Contoh Aplikasi
 - Rehabilitasi Bencana Gempa/Tsunami Palu
 - Analisis Kerentanan Bangunan terhadap Bencana Tsunami

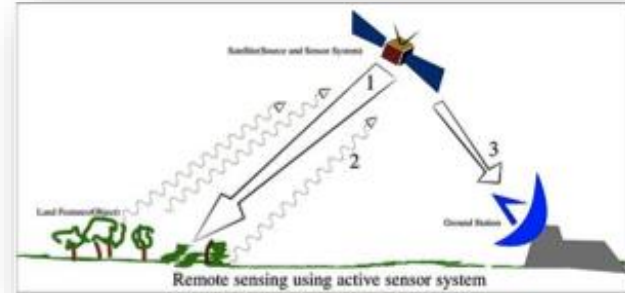
Sekilas tentang penginderaan jauh

Penginderaan jauh adalah ilmu pengetahuan dan seni dalam memperoleh informasi tentang suatu **objek, wilayah, atau fenomena** terutama di **permukaan bumi** yang dilakukan melalui analisis data yang diterima oleh suatu alat yang ***tidak bersentuhan langsung*** dengan objek, wilayah, atau fenomena yang diamati.

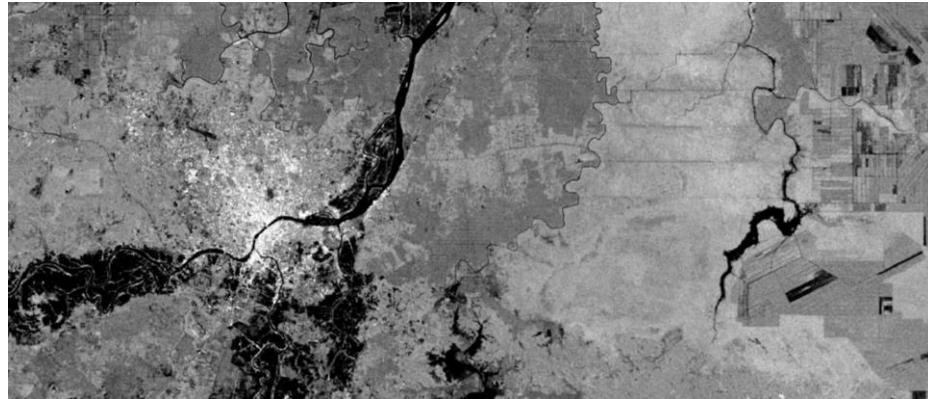
Karakteristik data penginderaan jauh



PASIF SENSOR

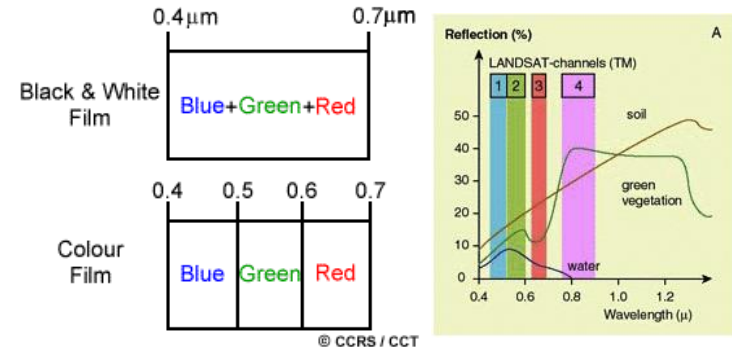
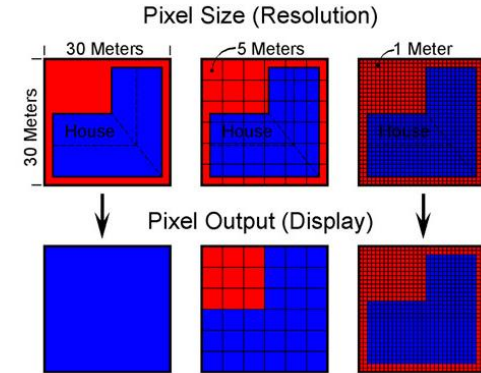


AKTIF SENSOR

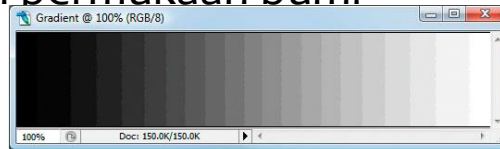


Resolusi spasial, spektral, dan radiometrik

- **Resolusi spasial** ialah ukuran terkecil objek (kerincian informasi) yang dapat direkam oleh sistem sensor.
- **Resolusi spektral** menunjukkan kerincian panjang gelombang yang digunakan dalam perekaman obyek.
- **Resolusi radiometrik** menjelaskan kepekaan sensor terhadap perbedaan terkecil kekuatan sinyal.
- **Resolusi Temporal** (revisit time) menjelaskan waktu satelit untuk kembali ke wilayah yang sama di permukaan bumi



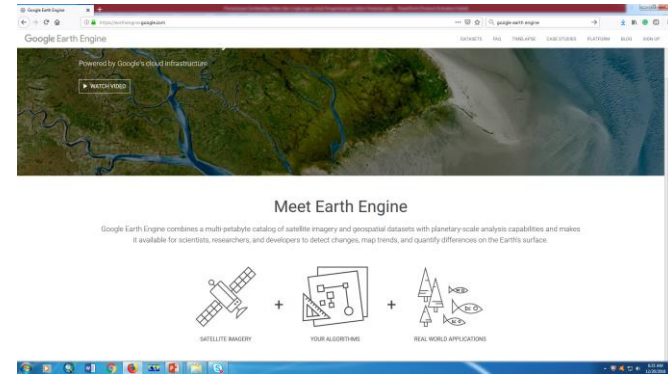
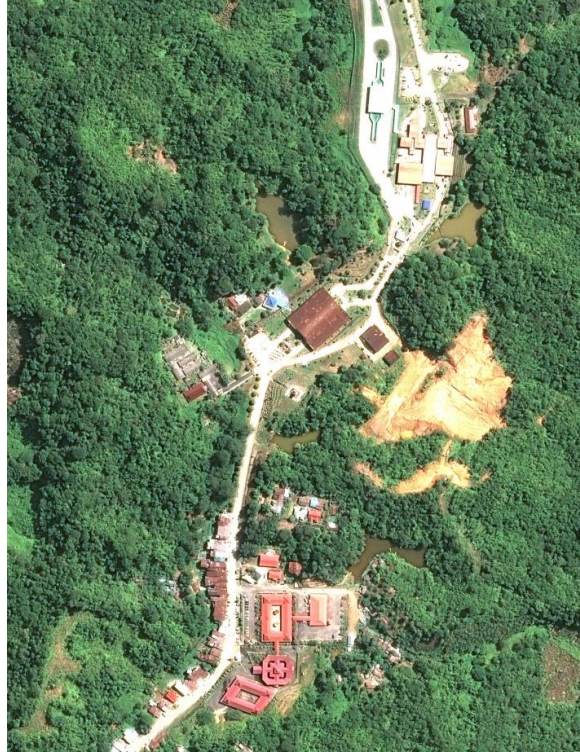
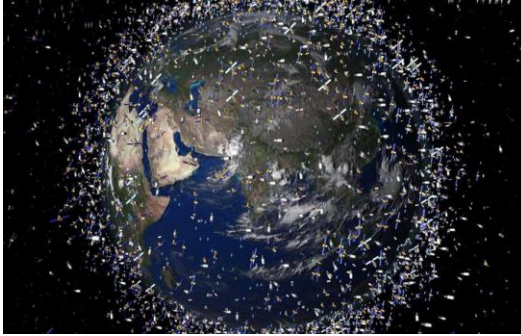
8-bit
(256 level)



16-bit
(65,536 level)



Perkembangan Penginderaan Jauh

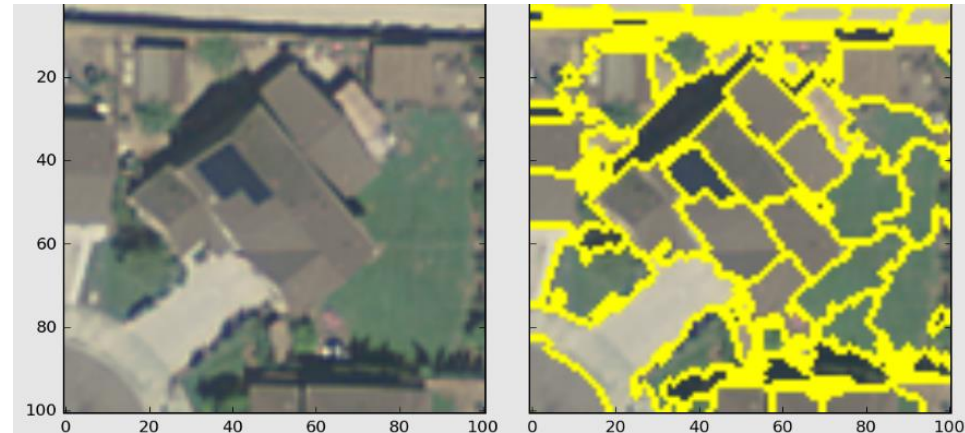
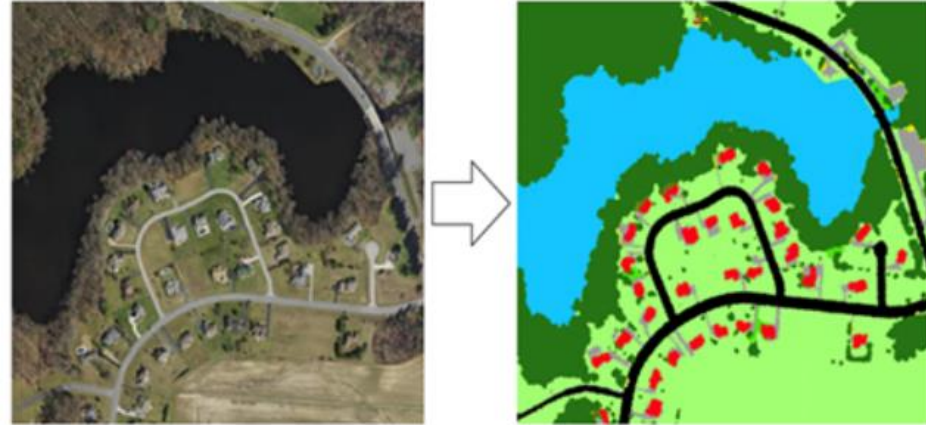
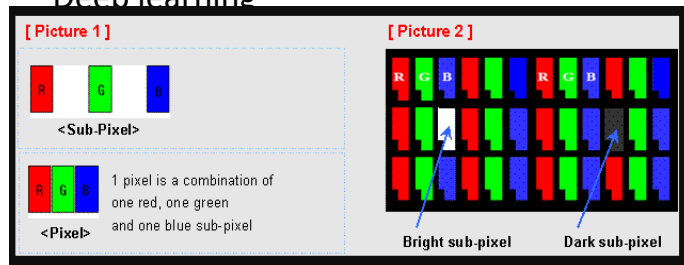


The development of remote sensing:

- More higher spatial resolution
- More faster revisit time
- Satellite constellation
- Micro and Nano satellite
- Platform data sharing
- Mapping engine
- Drone
- Machine learning, AI, IOT, Crowdsourcing

Metode Pengolahan Data Satelit Inderaja

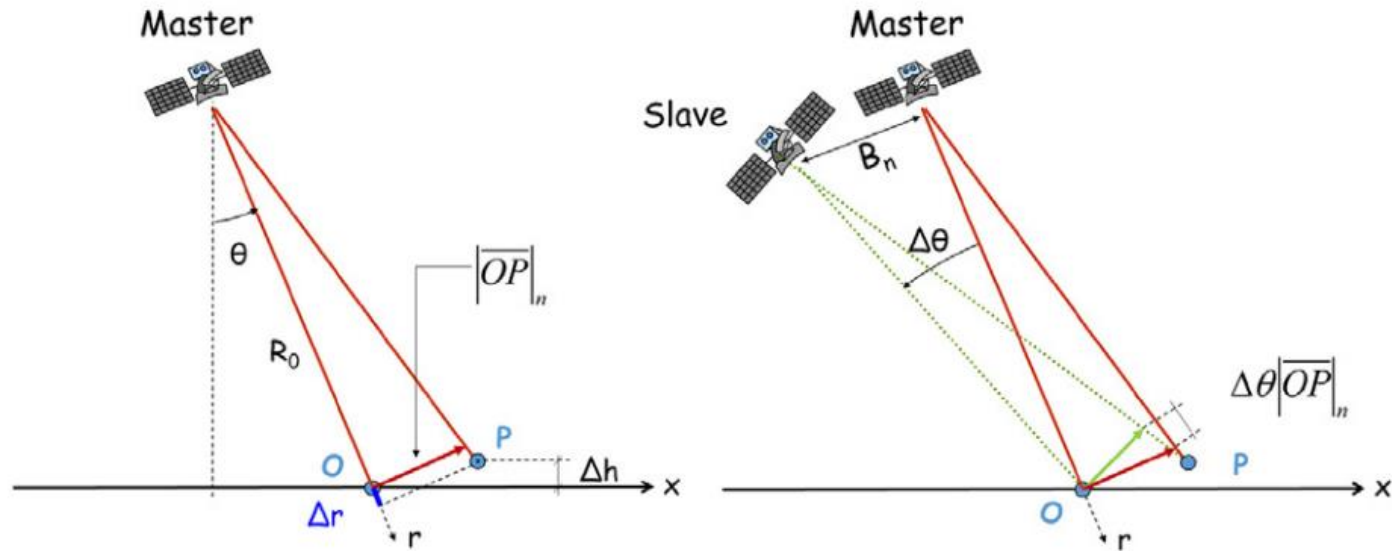
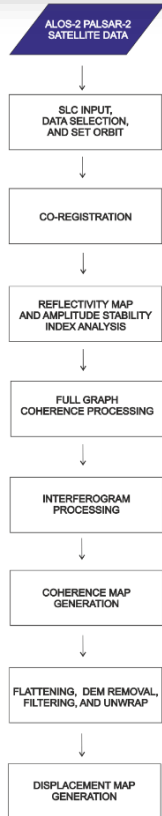
- Visual
- Digital
 - Pixel based
 - Sub-pixel
 - Object based
 - Index based
 - Change Detection
 - Fusi Data
 - ML/AI
 - Deep learning



Metode deteksi penurunan permukaan dengan satelit

Metode	Deskripsi	Keunggulan	Keterbatasan
Differential Interferometric SAR (D-InSAR)	Menggunakan dua citra SAR untuk menghitung perubahan fasa akibat deformasi.	Mudah, cepat, dan efisien untuk deformasi sederhana.	Sensitif terhadap atmosfer dan vegetasi.
Persistent Scatterer Interferometry (PS-InSAR)	Menggunakan serangkaian citra SAR untuk mendeteksi persistent scatterers.	Akurasi tinggi, tahan gangguan atmosfer.	Membutuhkan banyak data SAR dan fokus pada area urban.
Small Baseline Subset (SBAS-InSAR)	Menggunakan citra dengan baseline temporal dan spasial kecil.	Analisis area luas, mengatasi decorrelation.	Proses lebih kompleks dibandingkan D-InSAR.
Multi-Temporal InSAR (MT-InSAR)	Kombinasi PS-InSAR dan SBAS untuk analisis deformasi jangka panjang.	Akurasi tinggi, cakupan luas, dan robust terhadap atmosfer.	Membutuhkan banyak data dan komputasi tinggi.
Corner Reflector Interferometry (CR-InSAR)	Menggunakan reflektor buatan untuk pemantauan deformasi presisi tinggi.	Presisi tinggi (millimeter-level) dan stabilitas tinggi.	Biaya mahal, membutuhkan pemasangan reflektor.
Polarimetric Interferometry (Pol-InSAR)	Menggunakan informasi polarisasi untuk mendeteksi perubahan struktur.	Mampu menganalisis vegetasi dan deformasi secara bersamaan.	Proses rumit, memerlukan data polarisasi penuh.

METODE DINSAR



Phase Interferogram

$$\phi = \frac{4\pi}{\lambda} R_i$$

$$Int_{ik}(s, l) = Img_i(s, l) \cdot Img_k^*(s, l)$$

$$\phi_{ik}(s, l) = \phi_i(s, l) \cdot \phi_k(s, l)$$

$$\phi_{ik}(s, l) = \frac{4\pi}{\lambda} [R_i(s, l) - R_k(s, l)]$$

Normal Baseline Calculation

$$\Delta\theta = \frac{Bn}{R_k}$$

$$\Delta\phi_{ik} = \phi_{ik}(P) - \phi_{ik}(O) = \frac{4\pi}{\lambda} [R_{ik}(P) - R_{ik}(O)]$$

Phase Terrain Flat Removal

$$\Delta\phi_{ik}^{flat} = \frac{4\pi}{\lambda} \frac{Bn}{R_k} \frac{\Delta r}{\tan \theta} \text{ and } \Delta\phi_{ik}^{height} = \frac{4\pi}{\lambda} \frac{Bn}{R_k} \frac{\Delta h}{\sin \theta}$$

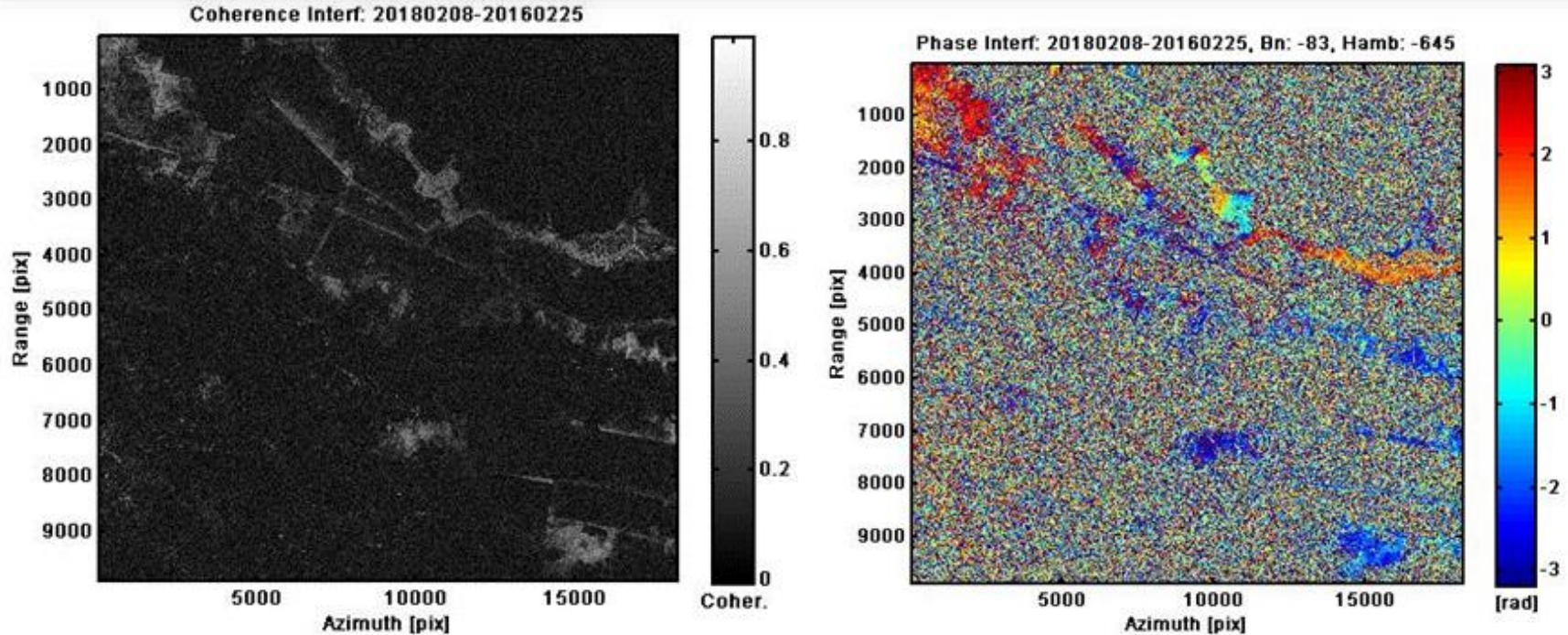
Topographic Phase Removal

$$\Delta\phi_{ik}^{DInSAR} = \Delta\phi_{ik} - \Delta\phi_{ik}^{flat} - \Delta\phi_{ik}^{height}$$

Unwrapping

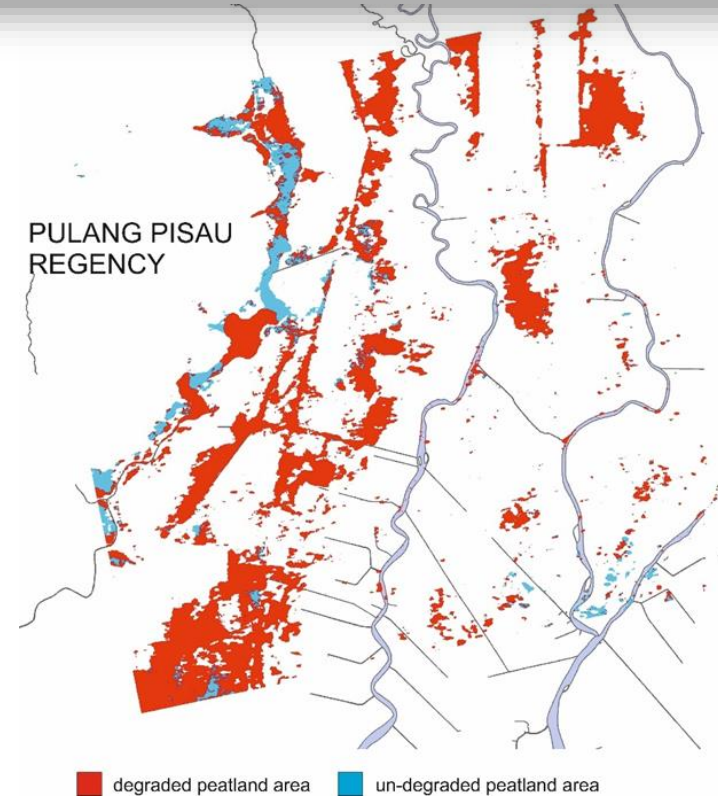
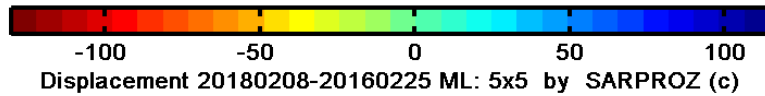
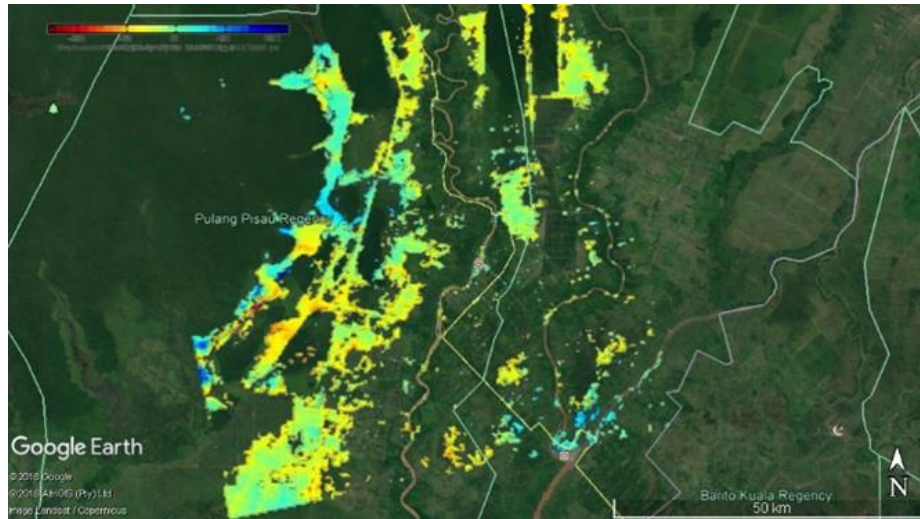
$$\Delta\phi_{ik}^{UW}(s, l) = \phi_{ik}(s, l) \pm 2n\pi$$

DInSAR – LAHAN GAMBUT



Coherence Image and Phase Interferogram Image of Peatland Area in Pulang Pisau

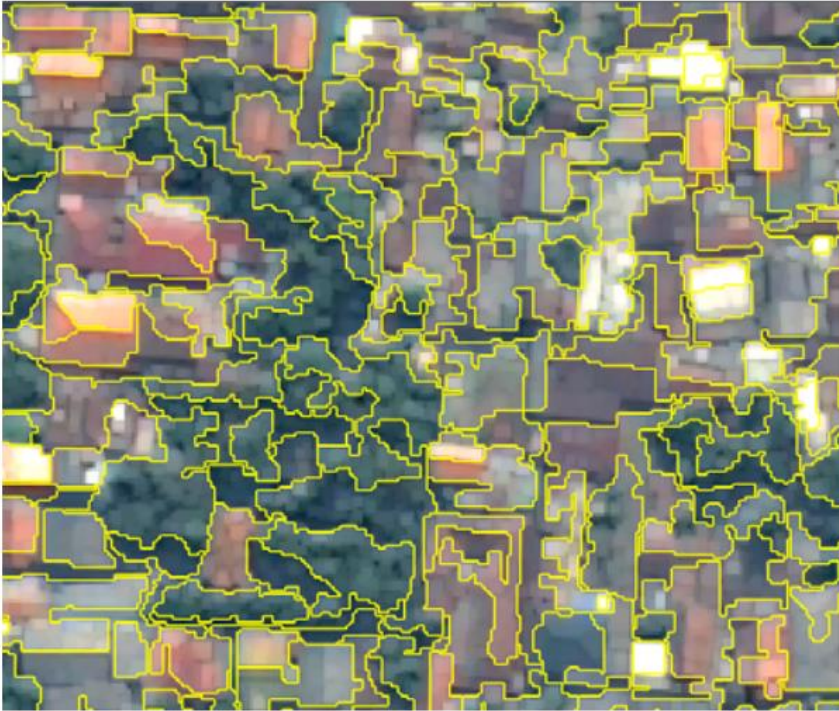
DInSAR – LAHAN GAMBUT



Software yang dapat digunakan

Nama Software	Fungsi	Keunggulan	Kekurangan
ESA SNAP (Sentinel Application Platform)	Pengolahan data Sentinel-1 dan sensor SAR lainnya, Mendukung D-InSAR, PS-InSAR (melalui plugin), dan SBAS-InSAR.	Gratis dan open-source, Mendukung berbagai sensor SAR.	-
GAMMA Software	Analisis SAR tingkat lanjut, termasuk PS-InSAR, SBAS-InSAR, dan D-InSAR.	Sangat fleksibel untuk penelitian SAR. Akurasi tinggi.	Berlisensi dan mahal.
SARscape (ENVI Add-on)	Integrasi dengan ENVI untuk analisis SAR, Mendukung PS-InSAR, SBAS-InSAR, dan CR-InSAR.	Antarmuka ramah pengguna, Dapat digunakan dengan data optik.	Berlisensi dan membutuhkan Software ENVI.
DORIS (Delft Object-oriented Radar Interferometric Software)	Fokus pada D-InSAR. Dikembangkan untuk tujuan penelitian.	Gratis untuk penelitian.	Antarmuka berbasis perintah (command-line).

Delineasi bangunan

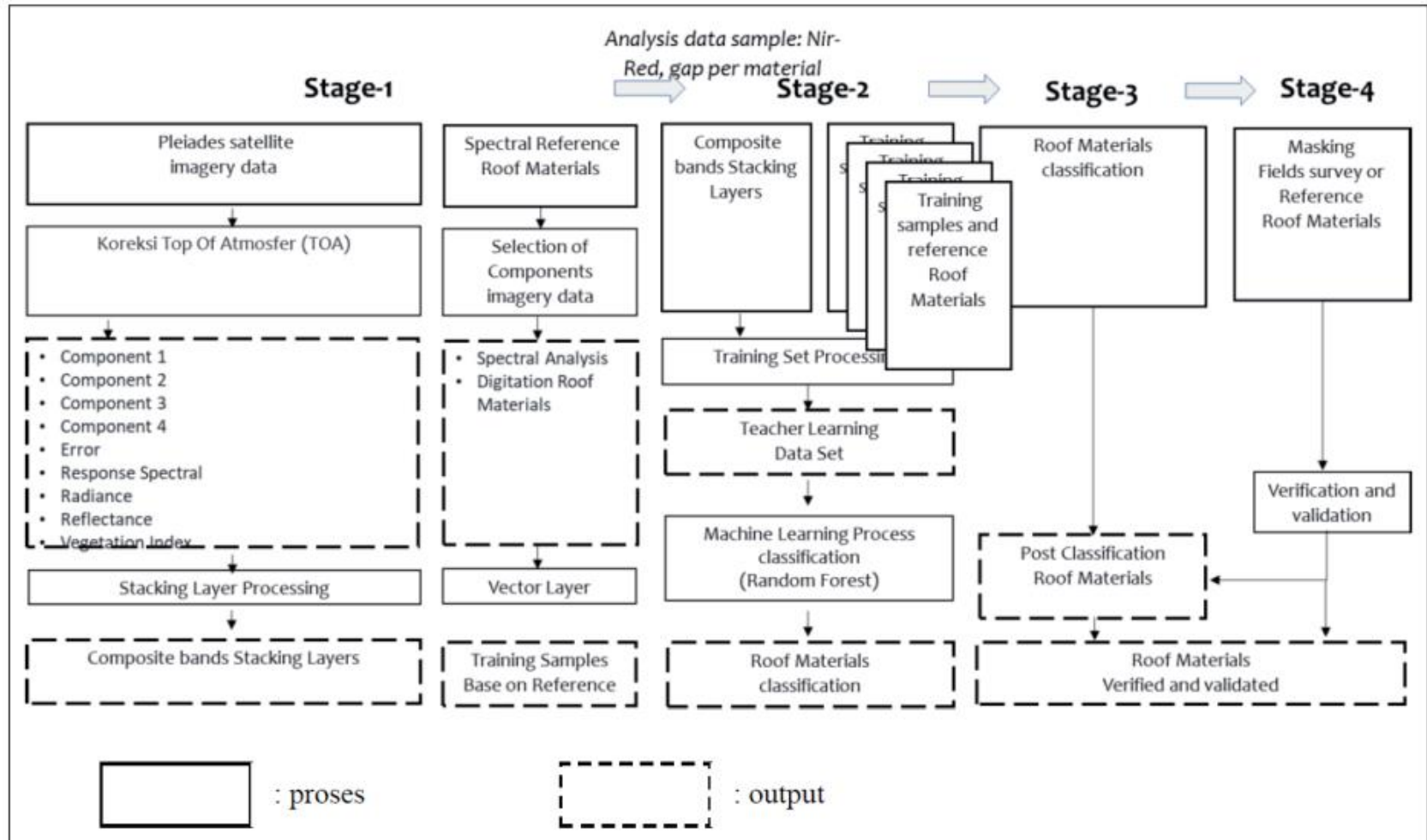


Digital Method (machine)

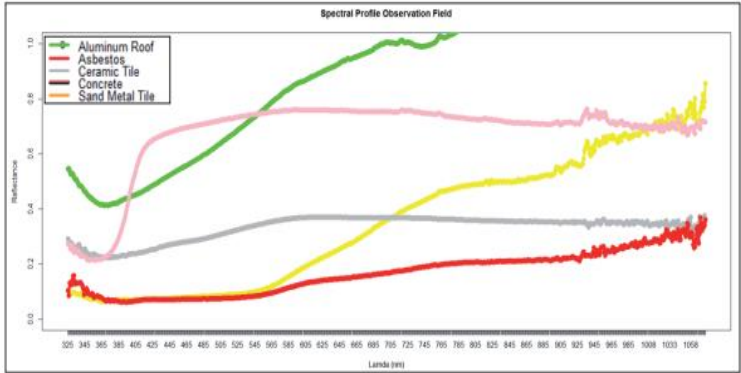
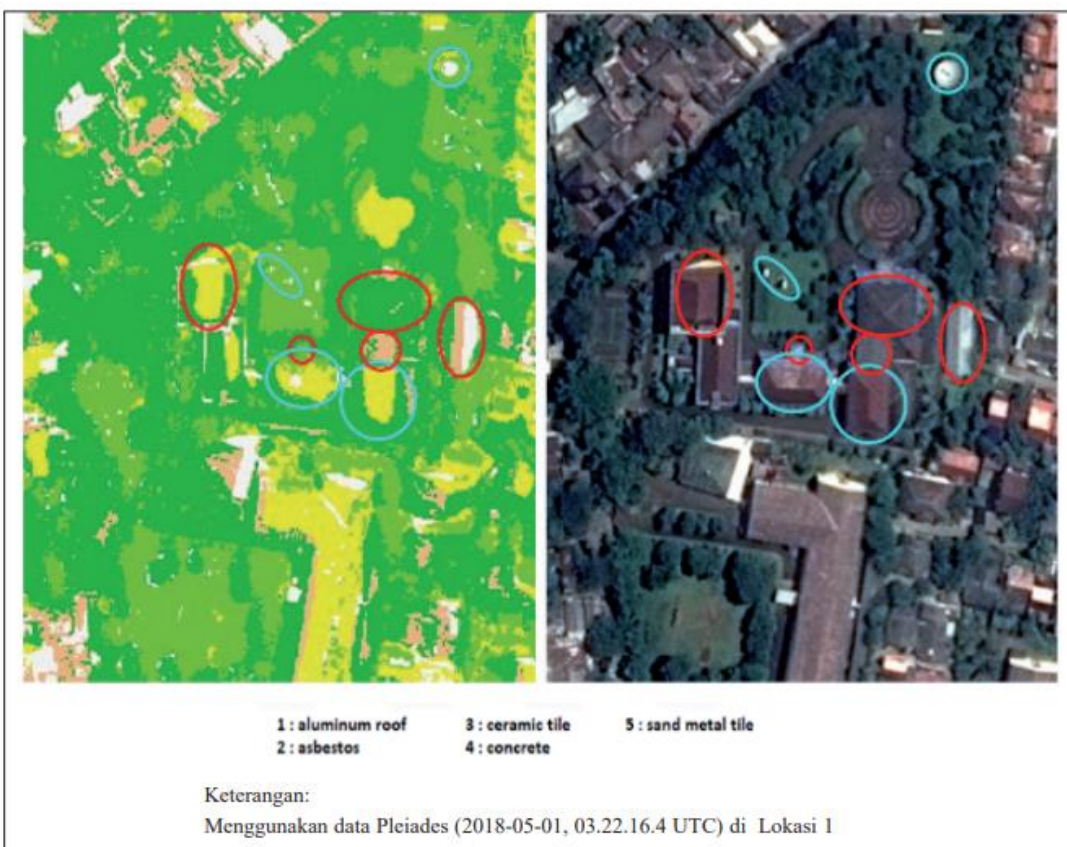


Metode Visual (manual)

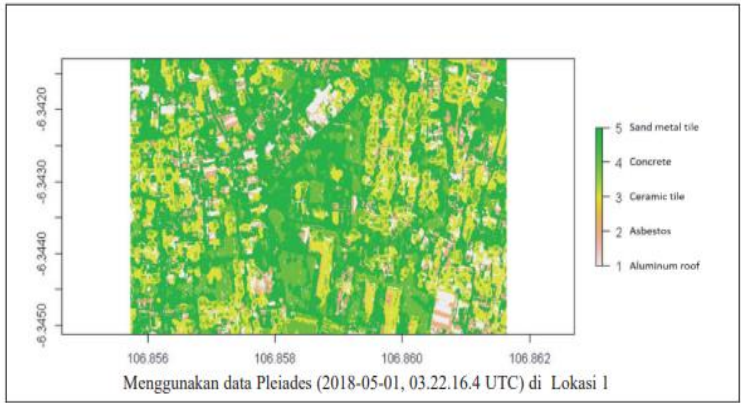
Deteksi Material Bangunan



Contoh hasil interpretasi



(b)



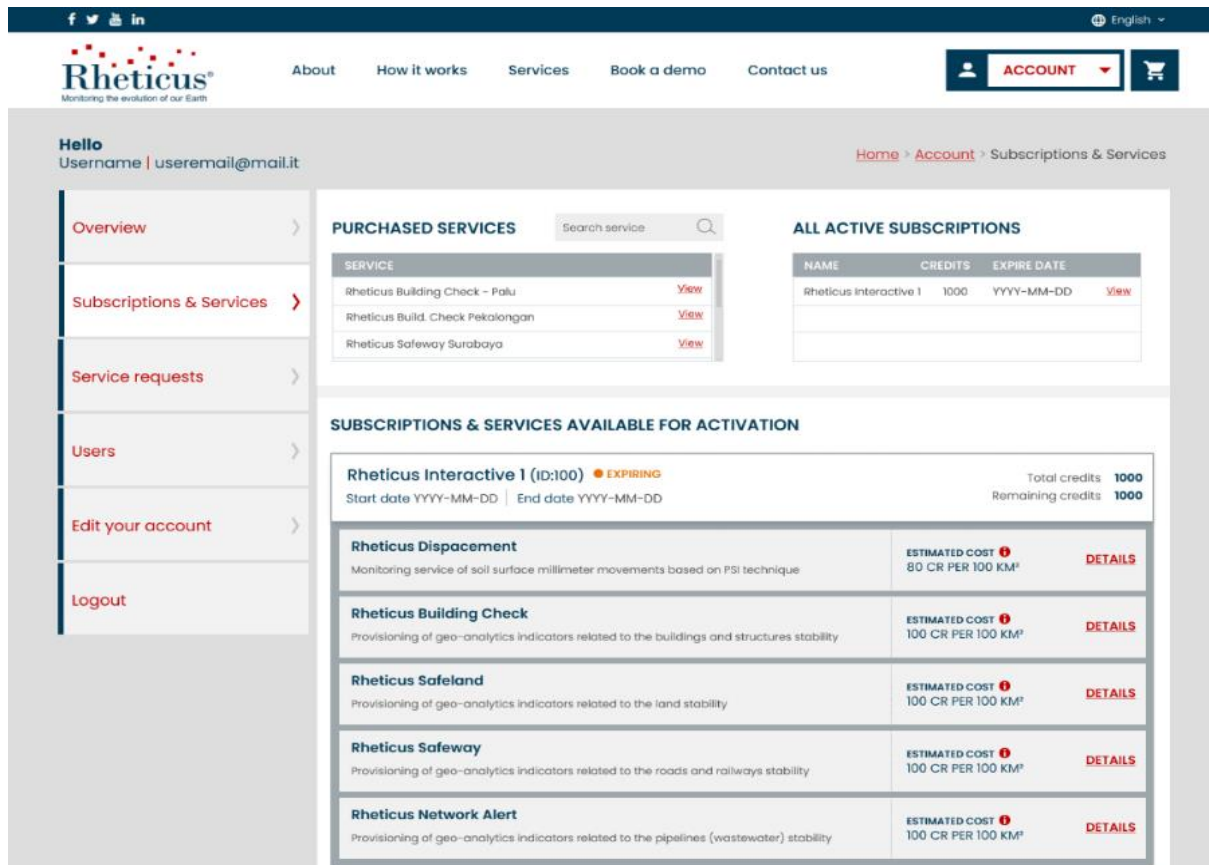


INSTABILITY AND GLOBAL CHALLENGE FOR MAINTENANCE



- Operators and authorities spend a lot of money fighting against **structural problems** due to natural or human-induced **land instability**;
- Land instability may cause structural damages and failures to roads and bridges, increased maintenance and repair costs, disruptions of service, accidents and casualties;
- **Ground displacement** is one of the best indicators for the likelihood of failure;
- The use of traditional techniques for periodic monitoring of wide networks requires **considerable economic and time resources**;
- Generally, surveys and inspections are performed when the **problems have already occurred** (i.e. damage or failure) due to lack of predictive info about what/where to inspect.

Rheticus® RHETICUS INTERACTIVE



The screenshot shows the Rheticus Interactive web application interface. At the top, there is a navigation bar with social media icons (Facebook, Twitter, LinkedIn) and the language set to English. Below this is a header with the Rheticus logo and navigation links: About, How it works, Services, Book a demo, and Contact us. On the right of the header are buttons for 'ACCOUNT' and a shopping cart icon.

The main content area is divided into a sidebar on the left and a main panel on the right. The sidebar contains a 'Hello' message with the username 'useremail@mail.it' and a list of navigation options: Overview, Subscriptions & Services (highlighted), Service requests, Users, Edit your account, and Logout.

The main panel displays the 'Subscriptions & Services' section. It includes a search bar for 'PURCHASED SERVICES' and a table of active subscriptions. Below this is a section for 'SUBSCRIPTIONS & SERVICES AVAILABLE FOR ACTIVATION'.

PURCHASED SERVICES	
Rheticus Building Check - Palu	View
Rheticus Build. Check Pekalongan	View
Rheticus Safeway Surabaya	View

ALL ACTIVE SUBSCRIPTIONS	
NAME	CREDITS EXPIRE DATE
Rheticus Interactive 1	1000 YYYY-MM-DD View

SUBSCRIPTIONS & SERVICES AVAILABLE FOR ACTIVATION		
Rheticus Interactive 1 (ID:100) ● EXPIRING Start date YYYY-MM-DD End date YYYY-MM-DD		Total credits 1000 Remaining credits 1000
Rheticus Displacement Monitoring service of soil surface millimeter movements based on PSI technique	ESTIMATED COST ⓘ 80 CR PER 100 KM²	DETAILS
Rheticus Building Check Provisioning of geo-analytics indicators related to the buildings and structures stability	ESTIMATED COST ⓘ 100 CR PER 100 KM²	DETAILS
Rheticus Safeland Provisioning of geo-analytics indicators related to the land stability	ESTIMATED COST ⓘ 100 CR PER 100 KM²	DETAILS
Rheticus Safeway Provisioning of geo-analytics indicators related to the roads and railways stability	ESTIMATED COST ⓘ 100 CR PER 100 KM²	DETAILS
Rheticus Network Alert Provisioning of geo-analytics indicators related to the pipelines (wastewater) stability	ESTIMATED COST ⓘ 100 CR PER 100 KM²	DETAILS

- Rheticus® is a cloud platform developed and operated by Planetek Italia, which provides geoinformative services for monitoring the evolution of the earth's surface, safeguarding infrastructures and protecting natural resources, using satellite images acquired periodically.
- The Rheticus® Interactive platform:
- Allows the end-user to manage the Rheticus® activations through processing credits.
- Allows users to request autonomously the activation of the Rheticus® services of own interest.



- Transportation



- Insurance / Property Management



- Utilities



- Natural Risk Management



- Geospatial interactive dashboard with **key indicators** and alerts
- **Historical** time-series analysis and **continuous updates**
- **Predictive** analytics, actionable information
- Cloud-hosted info-as-a service **subscription**



RHETICUS BUILDING CHECK

- Areas of Interest:**

- Jakarta
- Cirebon
- Pekalongan
- Semarang
- Surabaya

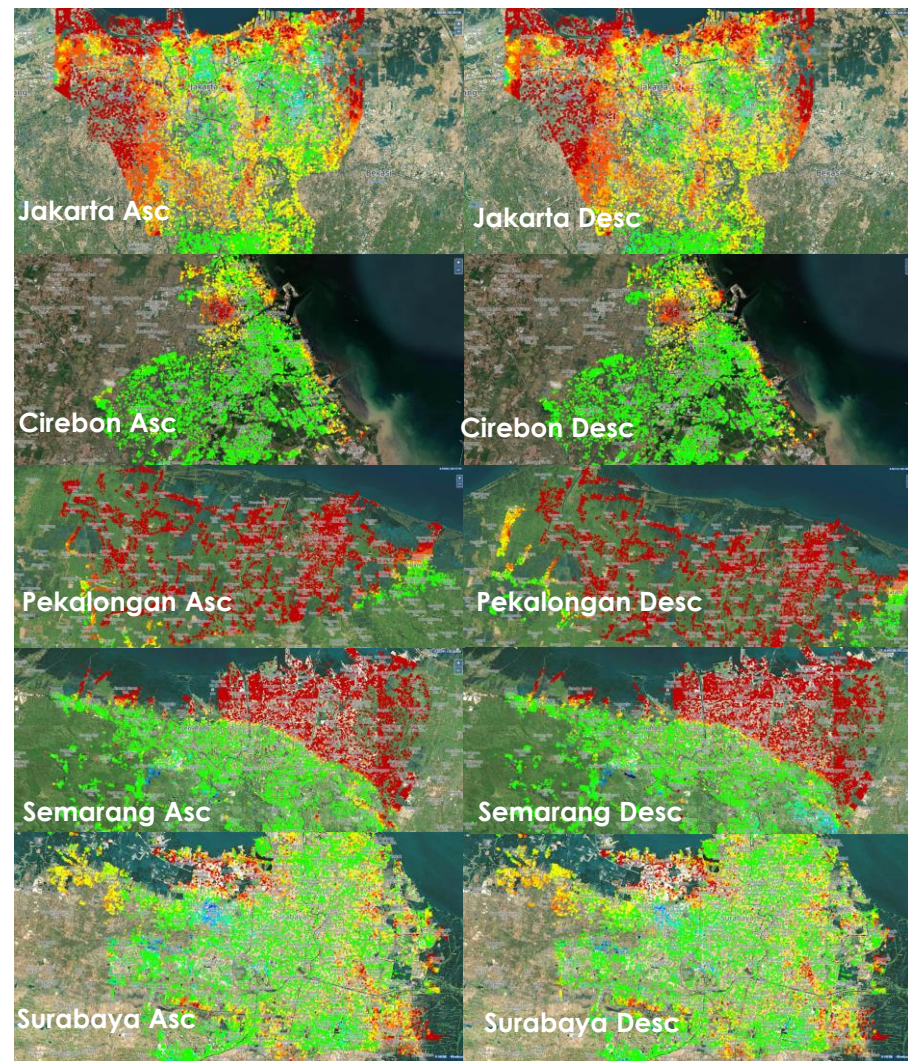
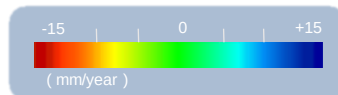
- Data used:**

- Satellite: Sentinel-1
- Orbit: Ascending and Descending
- Period: April 2015 – June 2021

- Methodology:**

The ground motion map obtained through the Rheticus® cloud platform that implements the Persistent Scatterers Interferometry technique, identifies zones and infrastructures more/less prone to instabilities. The ground motion map contains the average velocity of the measured points called Persistent Scatterers (PS) and Distributed Scatterers (DS) highlighting the areas and infrastructures that are moving with respect to the others that are stable.

The measured points are thematized based on the average velocity along the satellite Line-of-Sight (LOS), according to the following colour ramp:



Rheticus®

RHETICUS BUILDING CHECK

Rheticus® Building check – Building stability Methodology

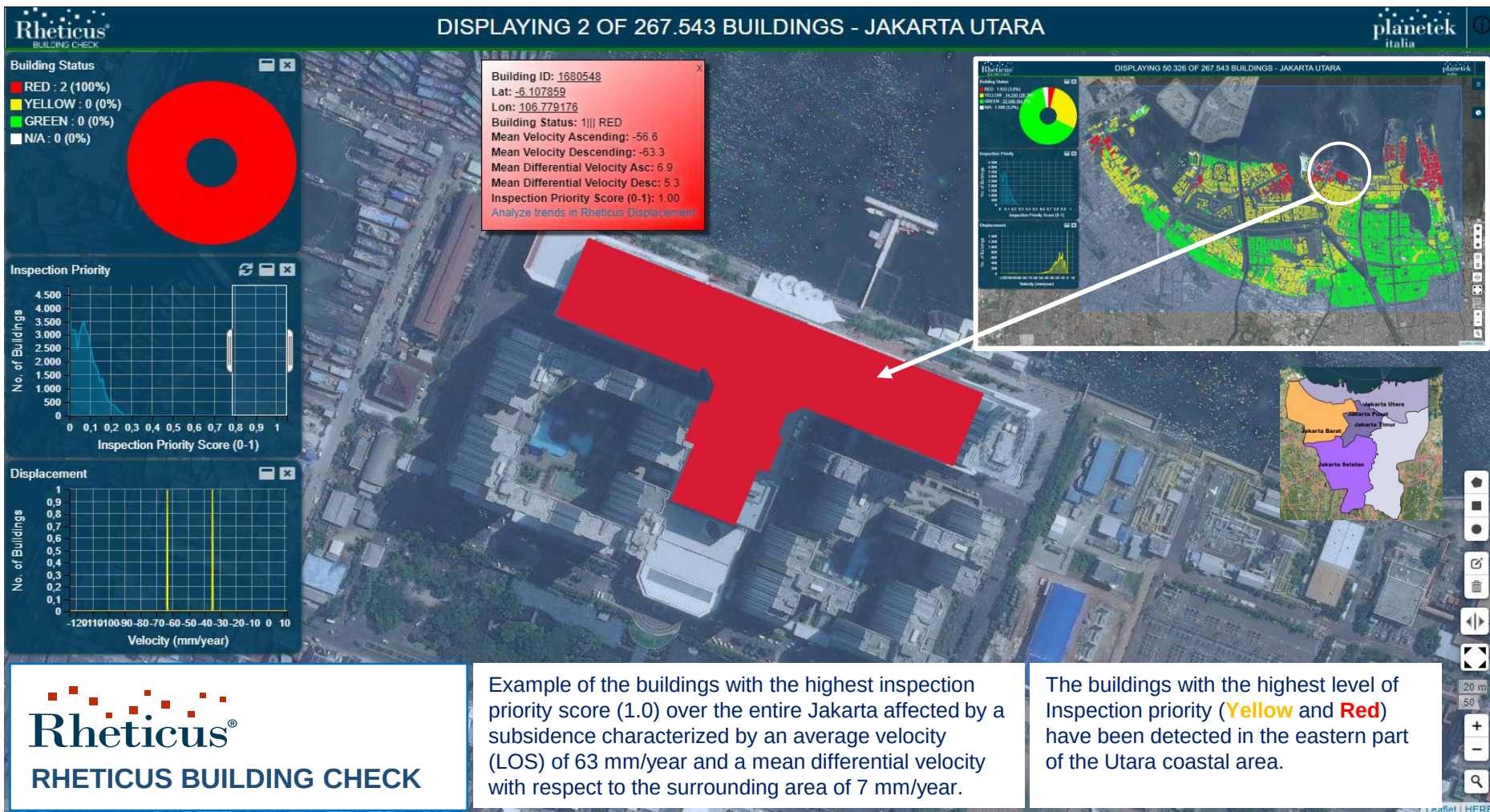
The buildings are classified in into 4 motion classes (Red, Yellow, Green, N/A) according to the normalized building motion Score[min: 0 – max:1] that is provided for each building.



FROM THE DISPLACEMENT
MEASUREMENTS

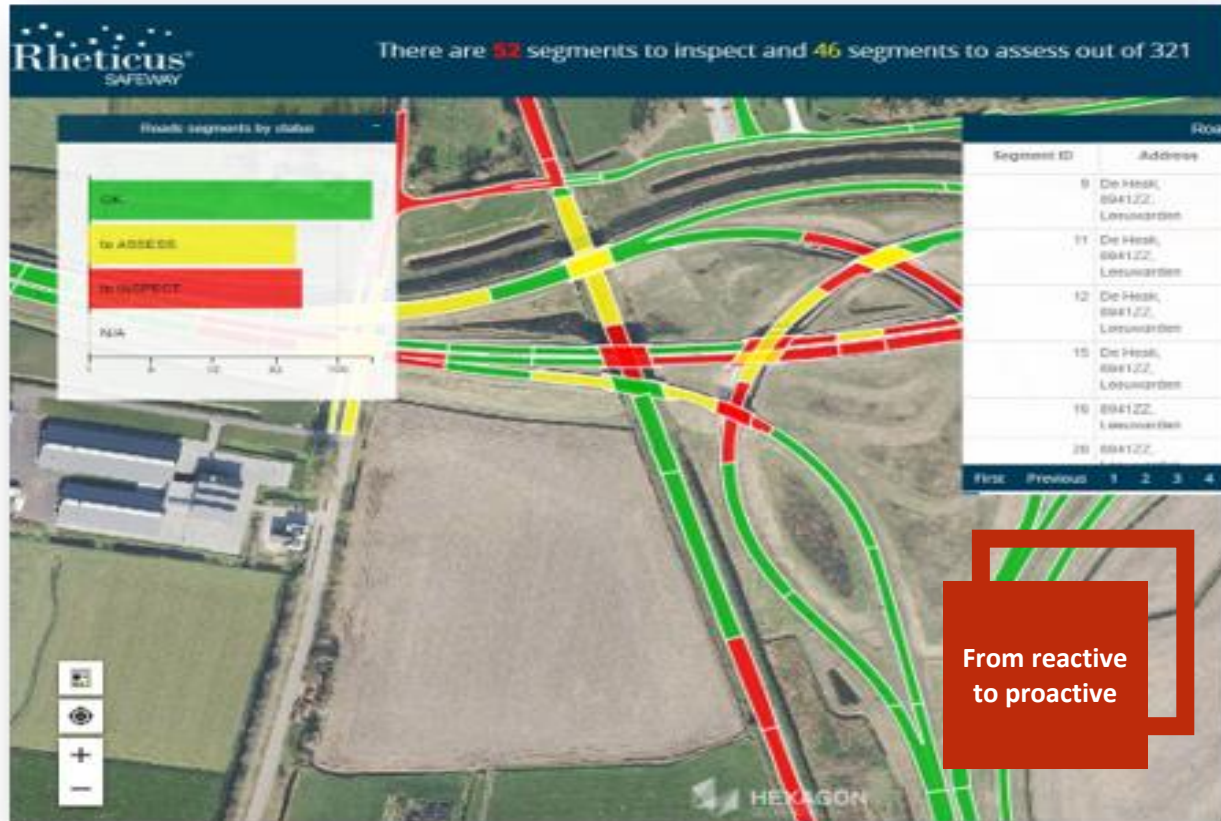


TO THE BUILDING STABILITY
LAYER



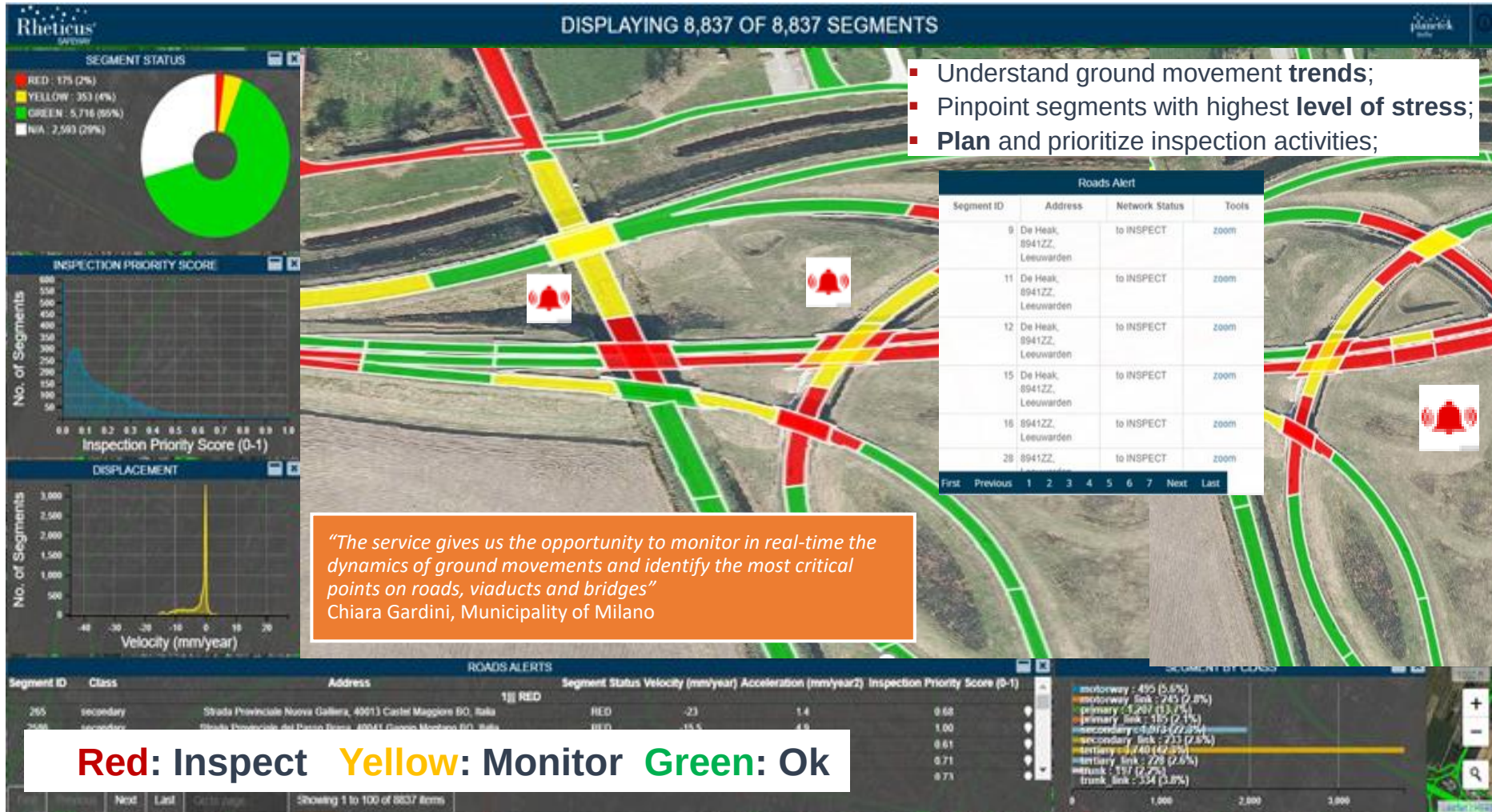


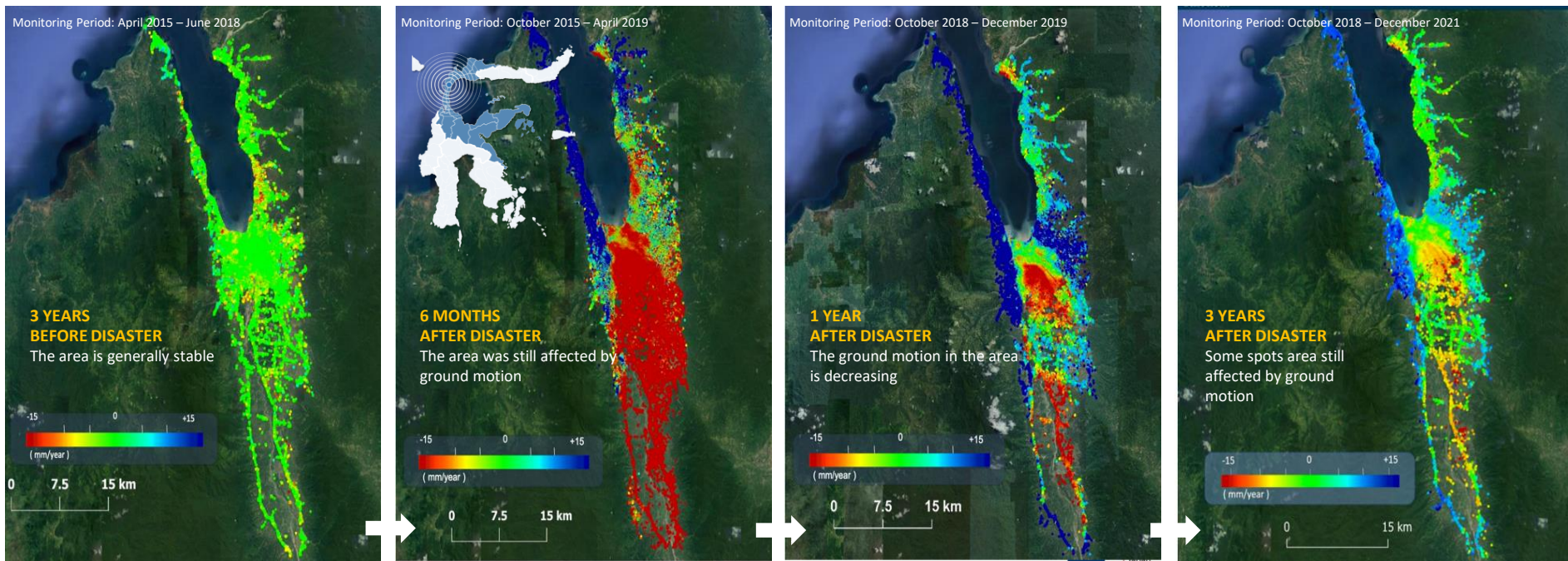
Inspection priority insights for roads and railways operator



From reactive
to proactive







The ground deformation analysis consists in the Multi-Temporal Interferometry processing of the Sentinel-1 images acquired in Descending orbit over Palu from 2015 – December 2021 through the Rheticus® Displacement service.

RHETICUS

Rheticus® is an automatic, cloud-based, geoinformation service platform. It's carefully designed to deliver insight accurate information, on our ever-changing world.

RHETICUS® BUILDING CHECK

Rheticus® Building Check provides predictive analysis of any building movement patterns within the monitored area of interest while also timely tracking any anomaly and its evolution over time. Building Check delivers periodic reports based on constant monitoring that allows quick detection of structural instability, supporting the local authorities in charge of the buildings management.

- Land movement maps and stability analysis have been extensively used to inform planning and engineering designs and to support the implementation of BUILD BACK BETTER



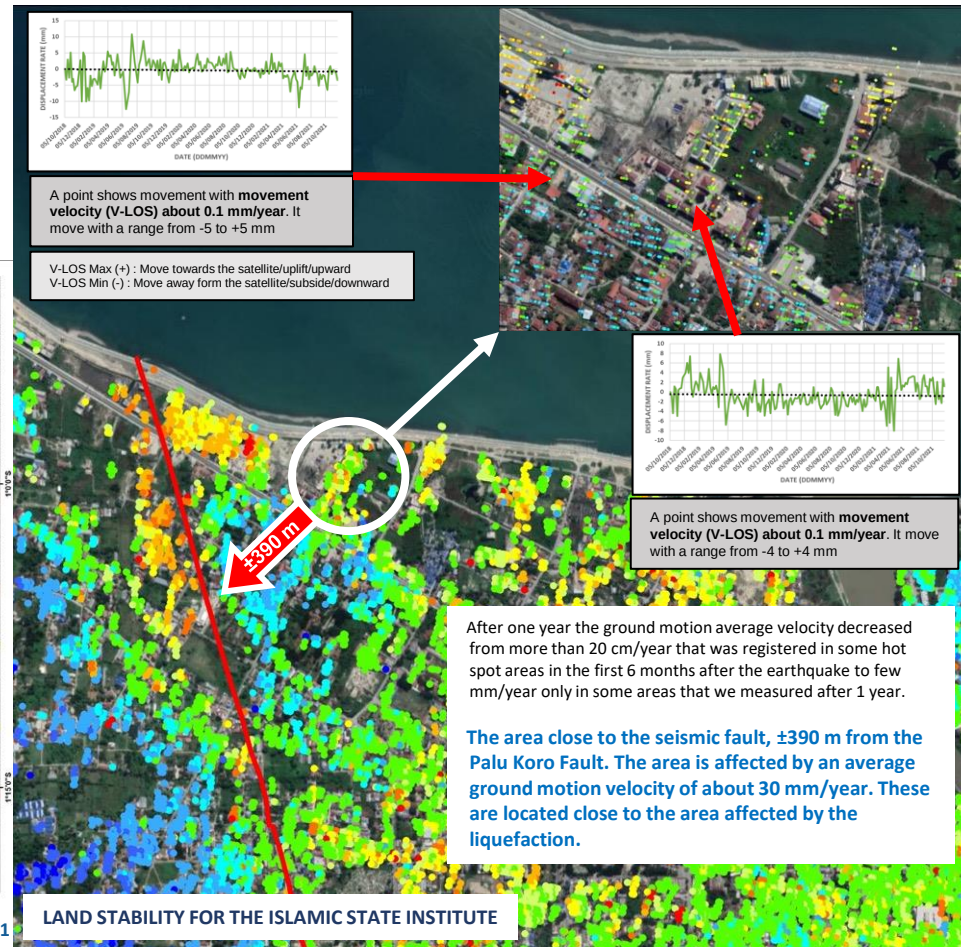
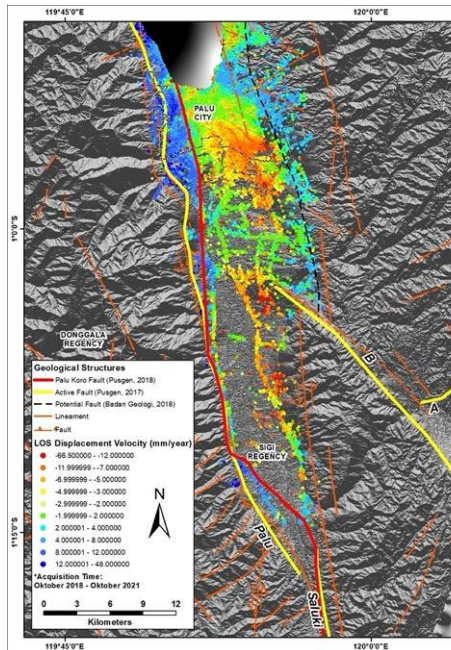
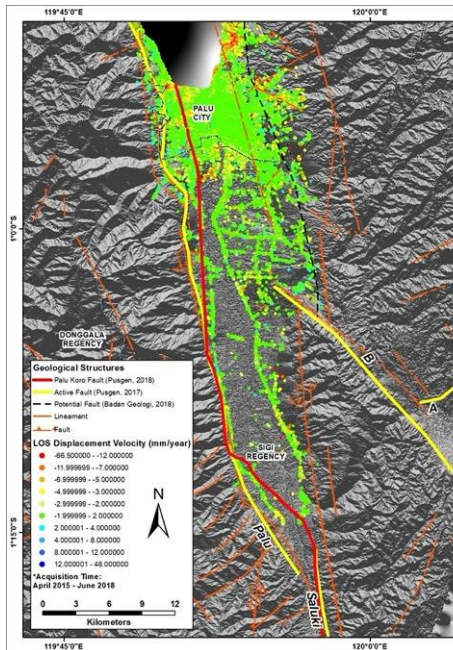
REMOTE SENSING APPLICATION FOR BUILD BACK BETTER FEATURES

LAND MOVEMENT MONITORING IN SUPPORTING THE REHABILITATION OF THE ISLAMIC STATE INSTITUTE (IAIN PALU)



MAIN BUILDING BACK BETTER ELEMENTS:

- DESIGN CHALLENGES
- GREEN CAMPUS AND BUILDING DESIGN.
- DISASTER-RESILIENT DESIGN.
- GENDER-RESPONSIVE AND INCLUSIVE DESIGN FEATURES.



• Monitoring Before Disaster: April 2015 - June 2018

• Monitoring After Disaster: October 2018 - October 2021

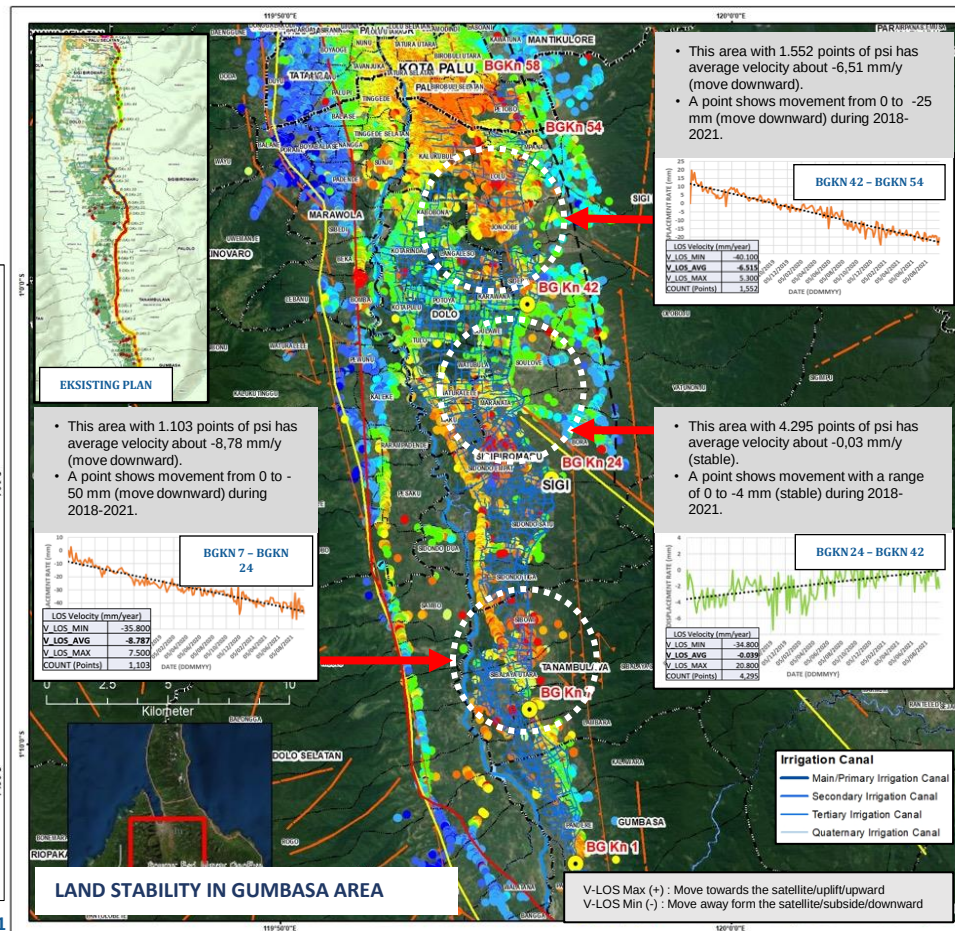
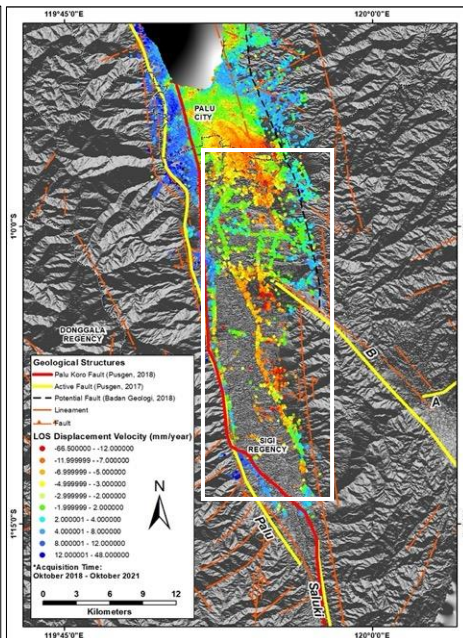
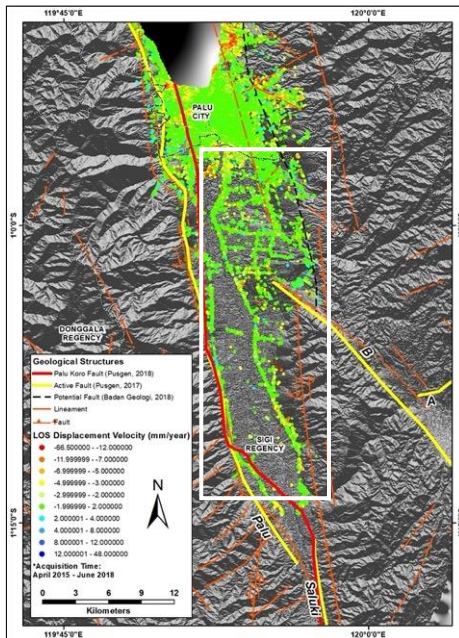
LOCATION OF ISLAMIC STATE INSTITUTE

LAND MOVEMENT MONITORING IN SUPPORTING THE REHABILITATION OF GUMBASA IRRIGATION SYSTEM



MAIN BUILDING BACK BETTER ELEMENTS

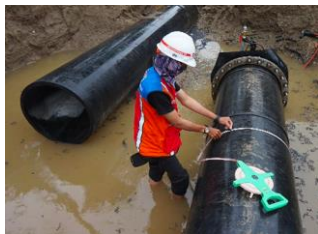
- THE REDESIGN SHOULD BE CONSISTENT WITH THE LEVEL OF DAMAGE
- REDESIGN OF THE MAIN CANAL
- MAIN CANAL STRUCTURES
- SECONDARY CANAL REPLACEMENT



- Monitoring Before Disaster: April 2015 - June 2018
- LOCATION OF GUMBASA IRRIGATION SYSTEM**

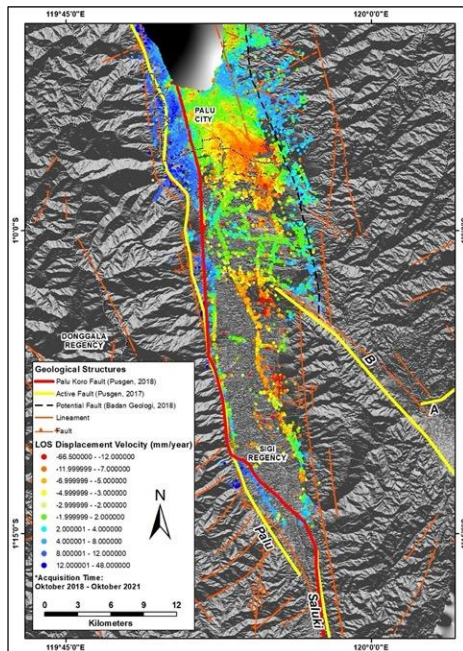
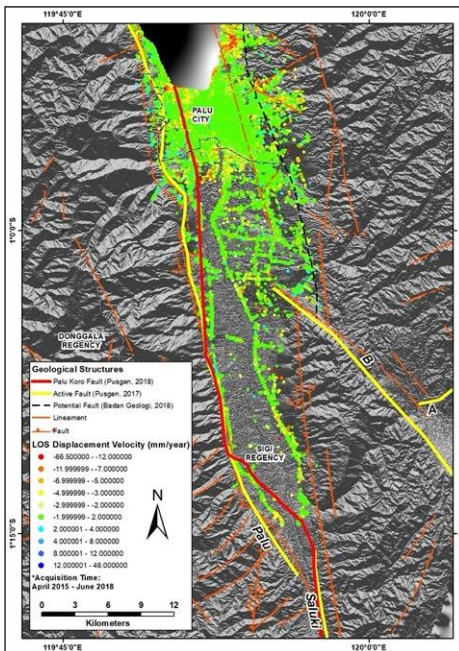
- **Monitoring After Disaster: October 2018- October 2021**

LAND MOVEMENT MONITORING IN SUPPORTING THE REHABILITATION OF PASIGALA RAW WATER SUPPLY SYSTEM



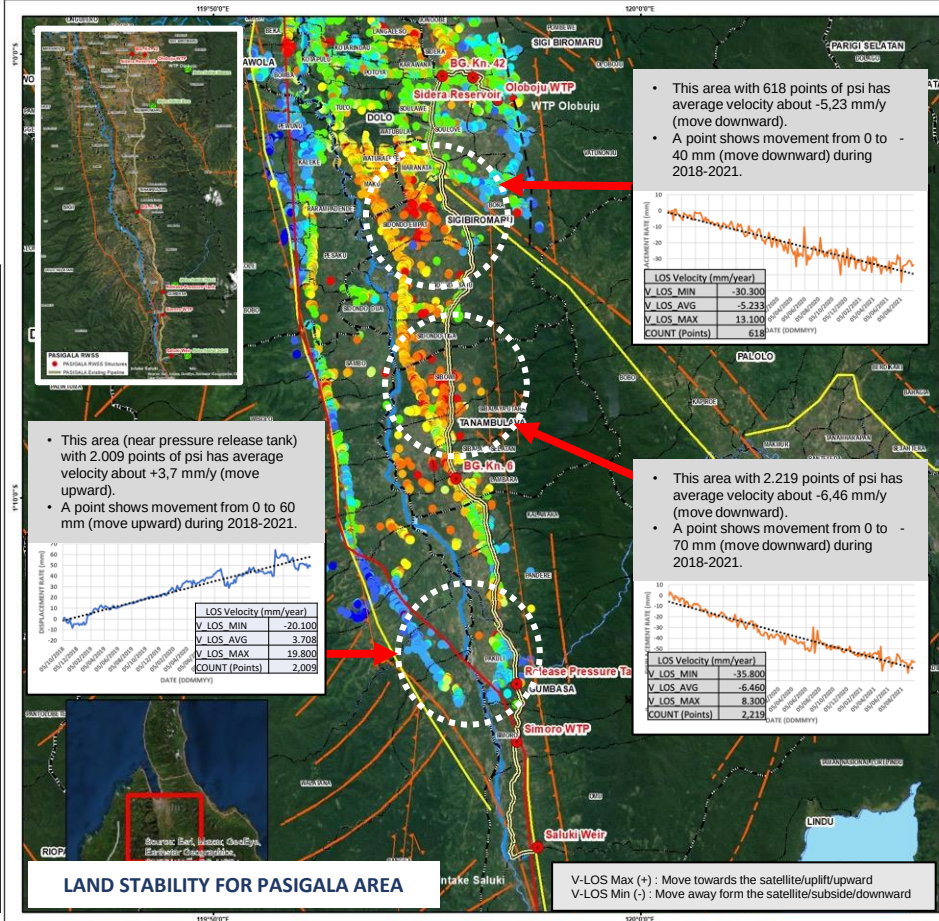
MAIN BUILDING BACK BETTER ELEMENTS

- INCREASED RAW WATER SUPPLY.
- EARTHQUAKE/ LIQUEFACTION RESISTANCE OF THE NEW TRANSMISSION PIPELINE.
- ENHANCING EARTHQUAKE/ LIQUEFACTION RESISTANCE OF THE EXISTING TRANSMISSION PIPELINE.
- PIPELINE MANAGEMENT AND LEAK DETECTION SYSTEM.

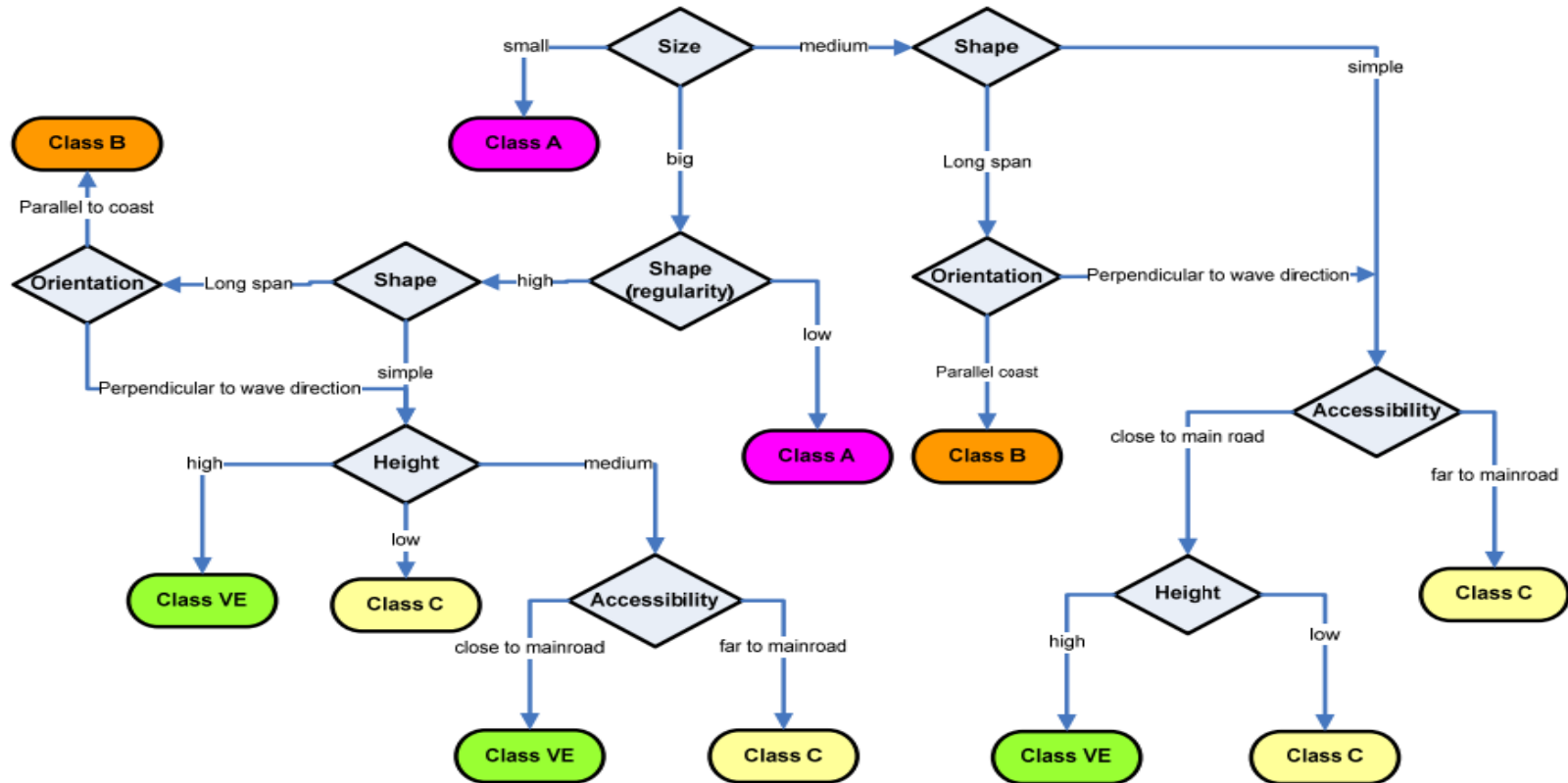


• Monitoring Before Disaster: April 2015 - June 2018
LOCATION OF PASIGALA RAW WATER SYSTEM

• Monitoring After Disaster: October 2018 - October 2021

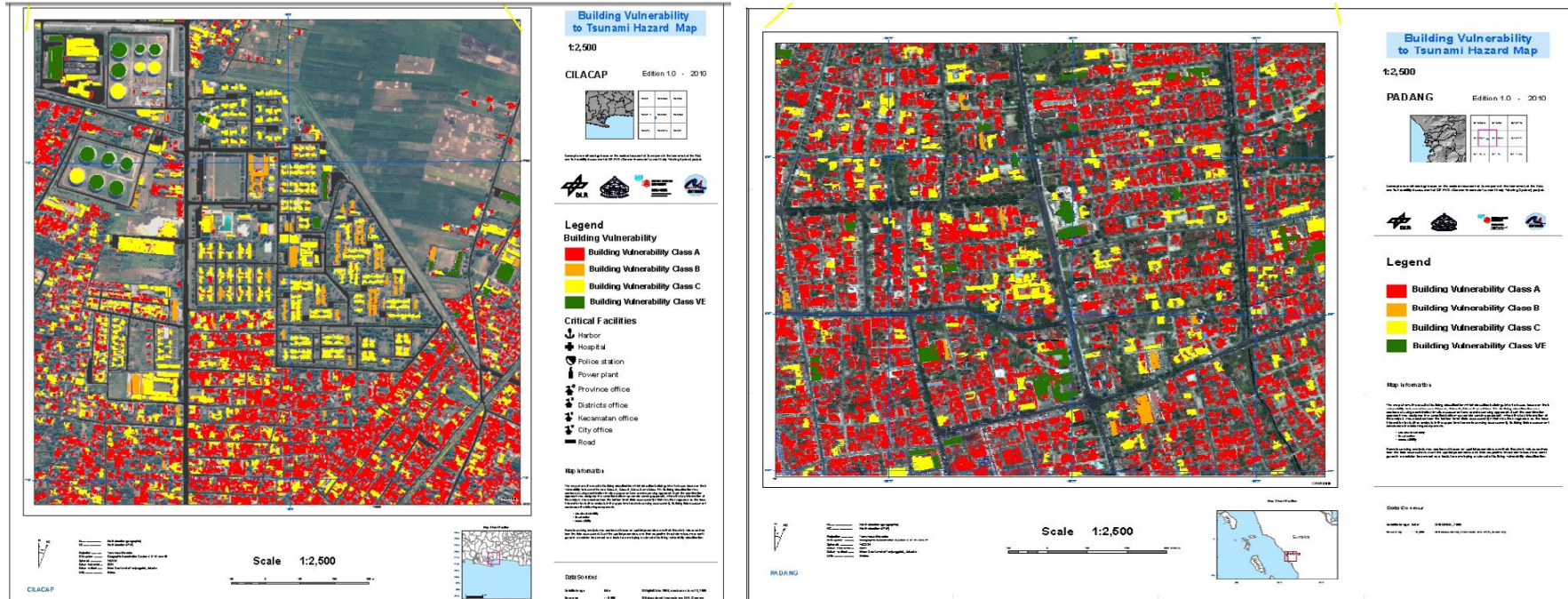


Metode Analisa kerentanan bangunan



(sumber: Sumaryono (2010))

Analisa Kerentanan Bangunan Terhadap Bencana



Kerentanan bangun terhadap tsunami di Cilacap (Kiri) dan Padang (kanan) (sumber: Sumaryono (2010))



THANK YOU