

GRUP DISKUSI - FORUM GURU BESAR ITB, BANDUNG 28 MEI 2016  
REKLAMASI PANTAI UTARA JAKARTA

**Land Subsidence Jakarta dan  
Dampaknya Terhadap Strategi Penanganan Banjir  
(dari Perspektif Geotechnical Engineering)**

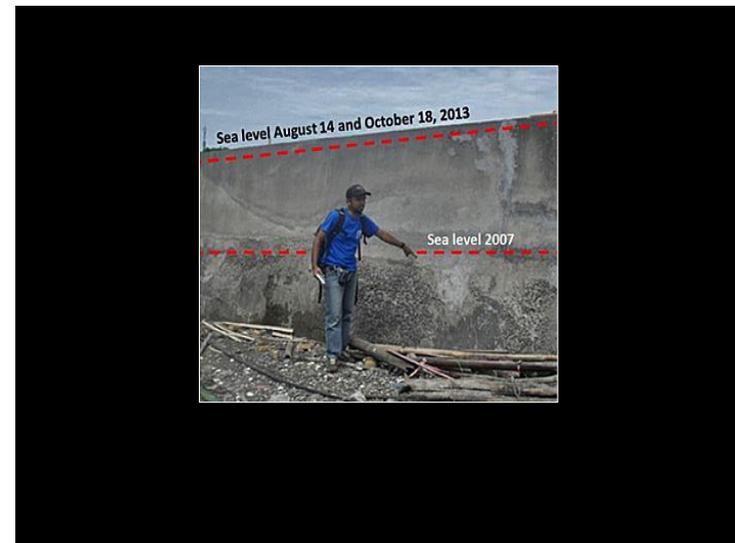
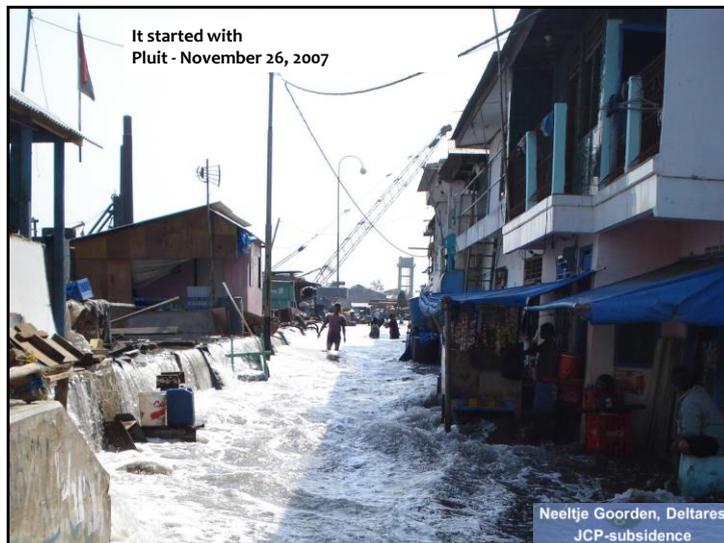
 Masyhur Irsyam

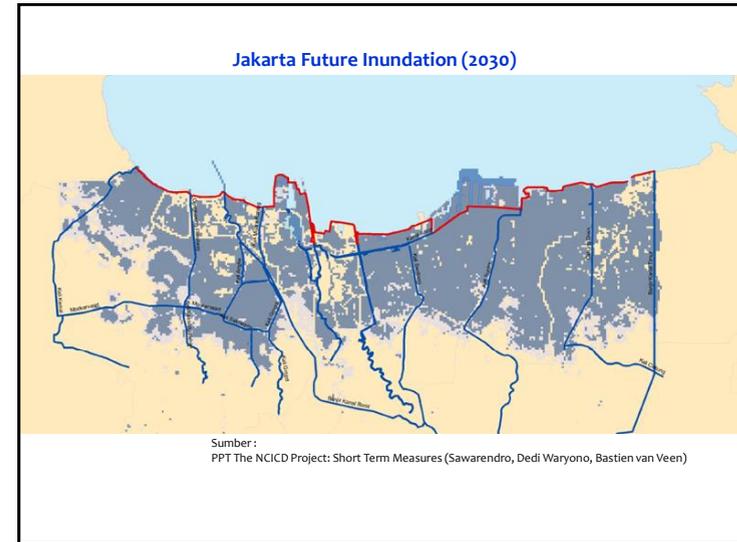


## What is causing Jakarta Flood?

- Causes of flood, naturally, is not only high rainfall, sea level rise, or not functioning optimally of drainage system but is also caused by **land subsidence**
- **Land subsidence phenomenon in Jakarta result in inundation area that become more widely**

Masyhur Irsyam 





**Content:**

1. Land Subsidence along North Seaside of Java
2. Causes of Land Subsidence
3. The Impact of Prediction of Land Subsidence
4. Required Urgent Information

**What is Land subsidence?**

- Land subsidence is a gradual settling or sudden sinking of the Earth's surface owing to subsurface movement of earth materials. (def. by USGS)
- Subsidence is a problem everywhere. This phenomena occur in many big cities in the world such as: San Joaquin Valley (California, USA), Mexico City (Mexico), Tokyo (Japan), Bangkok (Thailand), Jakarta (Indonesia) etc.

Noppadol, DRC, 2012

### LAND SUBSIDENCE PHENOMENON IN THE WORLD

Negara/Kota	Tahun Kejadian	Kisaran Kedalaman Kompaksi (m)	Penurunan Muk. Tanah maks (m)
Mexico/Mexico City	1948 – 1960	10 – 50	9 (15)
Jepang/Osaka	1948 – 1965	10 – 500	3 – 4 (15)
Jepang/Tokyo	1938 – 1975	10 – 500	4 – 6 (15)
Thailand/Bangkok	1978 – 1989	5 – 200	1 – 1.5 (15)
Taiwan/Taipei	1961 – 1975	30 – 200	1.8 (15)
USA/Arizona	1948 – 1967	100 – 300	3.2 (15)
USA/Houston	1943 – 1973	50 – 600	2.3 (15)
USA/San Joaquin	1935 – 1966	90 – 900	8.8 (15)

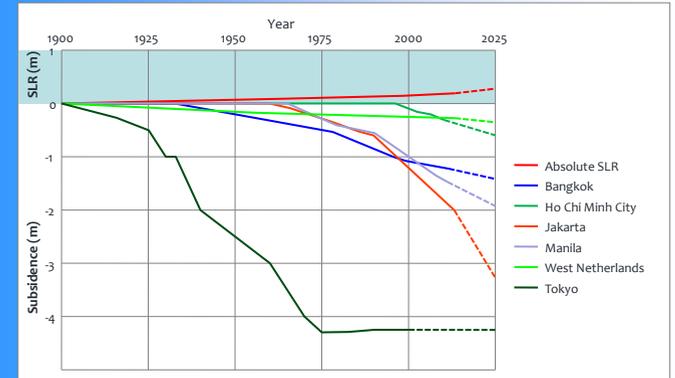
Investigation of landsubsidence caused by deep well pumping, research report

Land Subsidence at San Joaquin Valley, California (source: USGS, 2000)

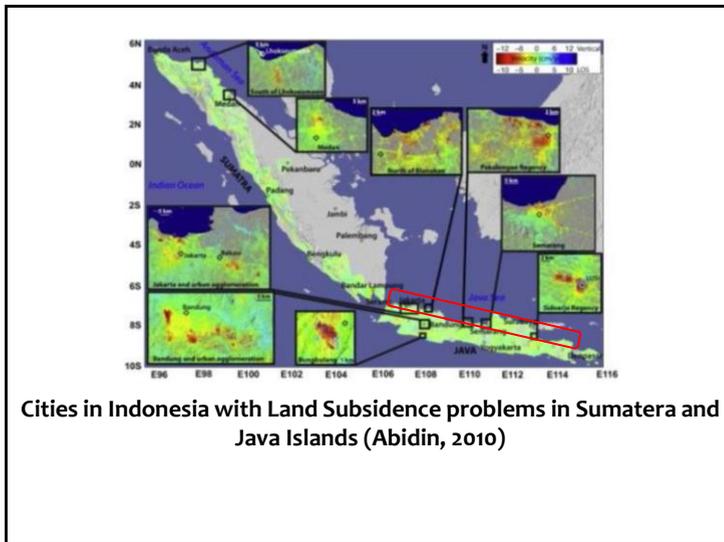


Prof. Ir. Masy

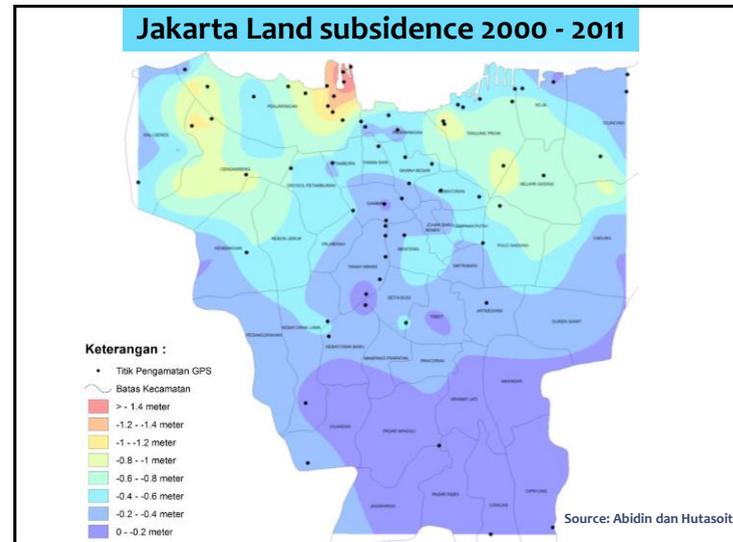
### Comparison between Sea level rise (top red line) and land subsidence in various cities/area's (source: Deltares)



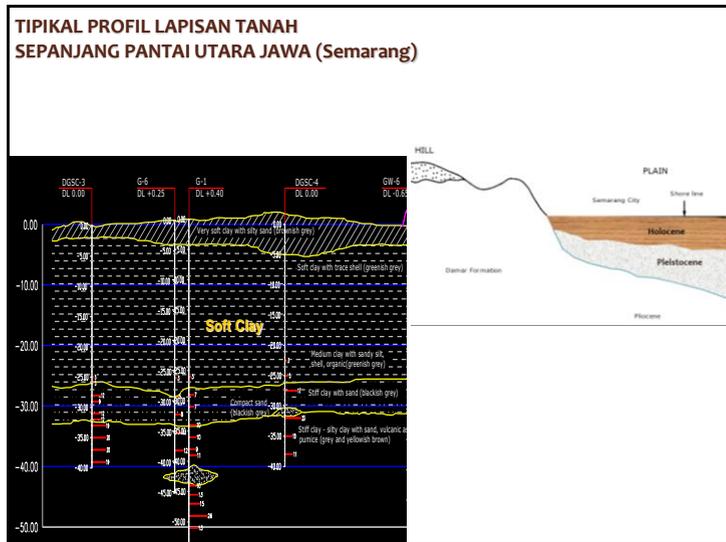
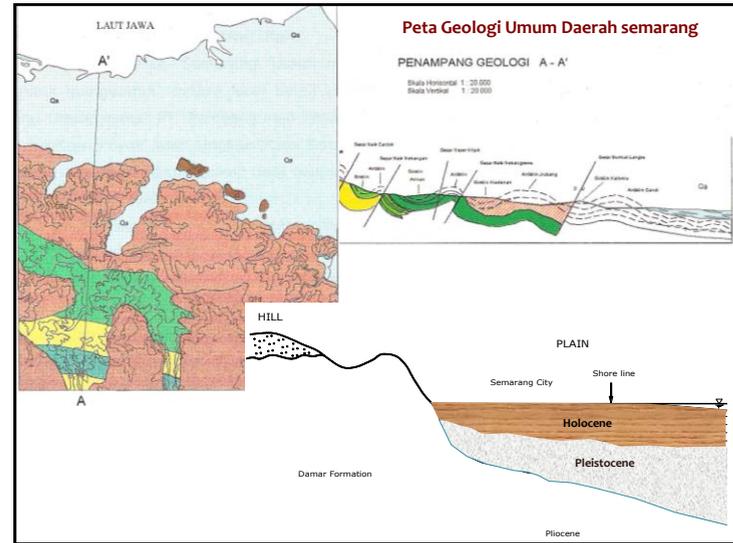
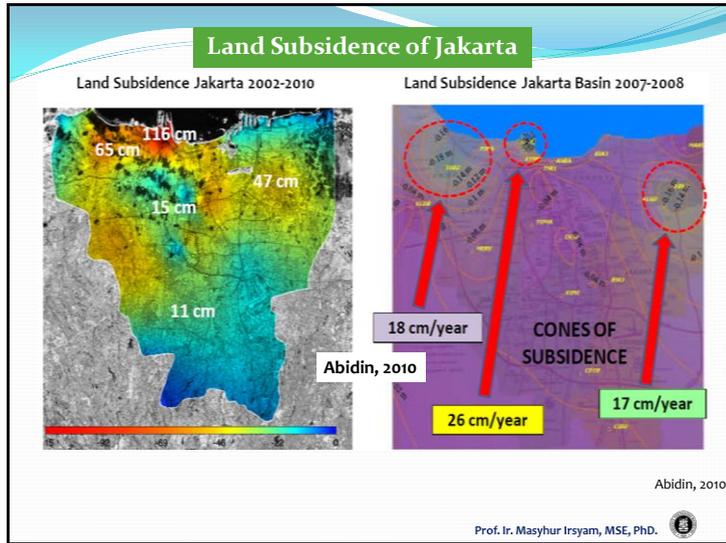
Deltares

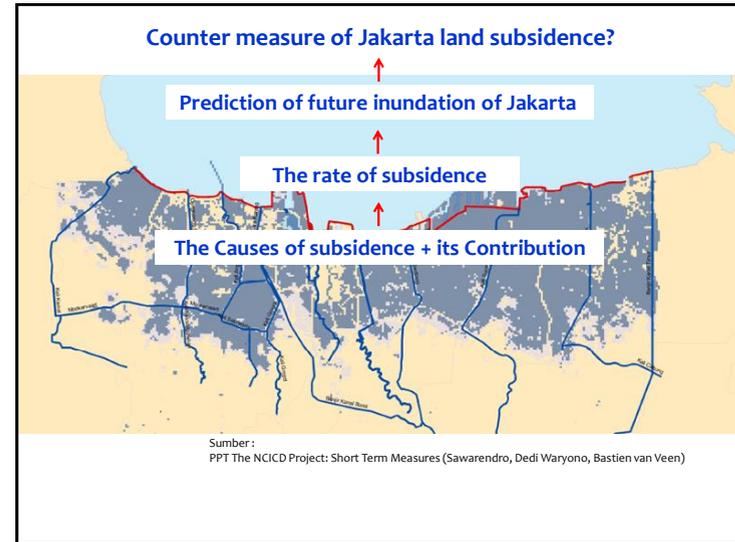


Cities in Indonesia with Land Subsidence problems in Sumatera and Java Islands (Abidin, 2010)



Source: Abidin dan Hutasoit





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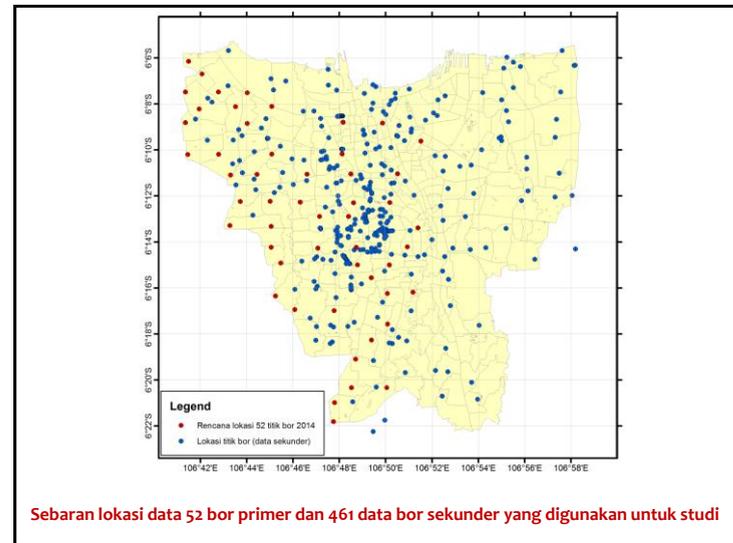
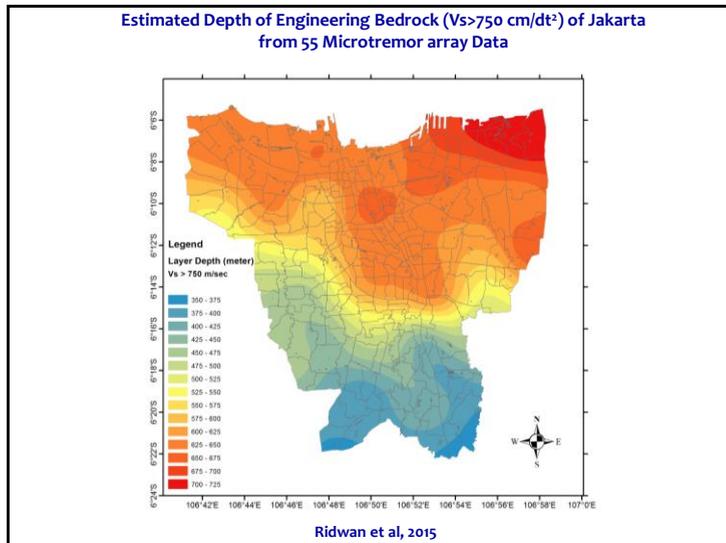
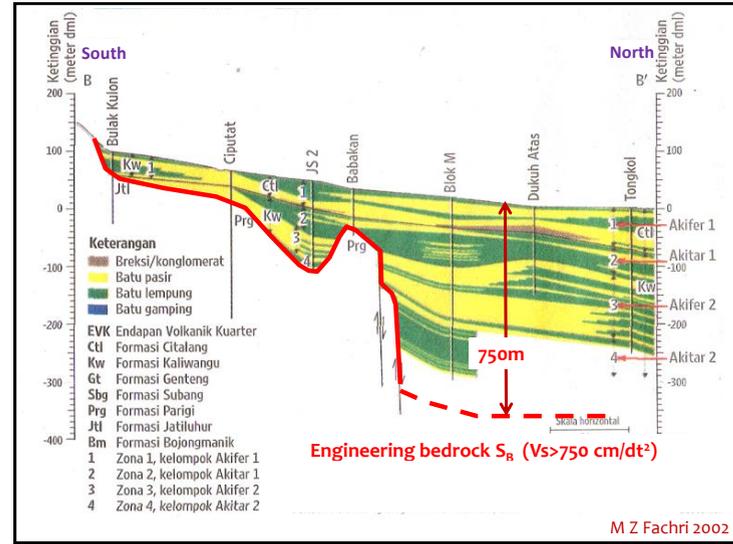
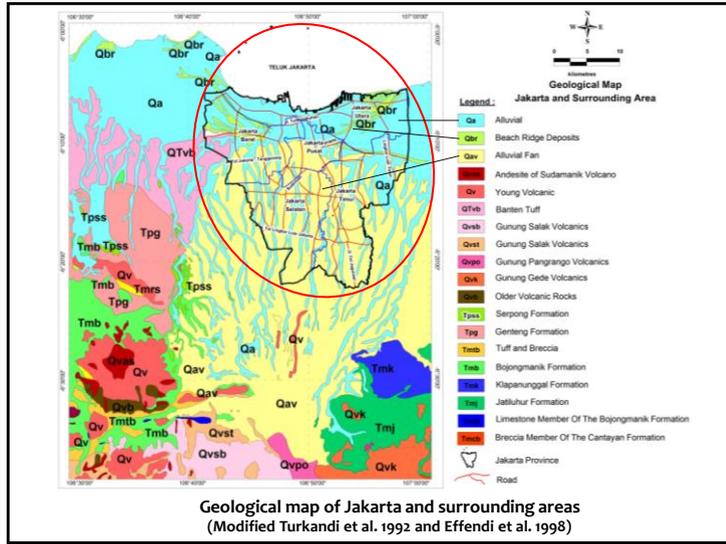
**Predicted Causes of Land Subsidence**

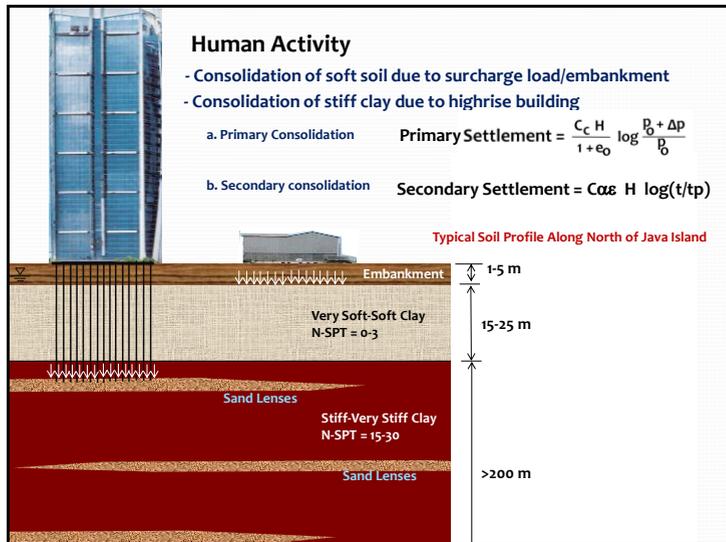
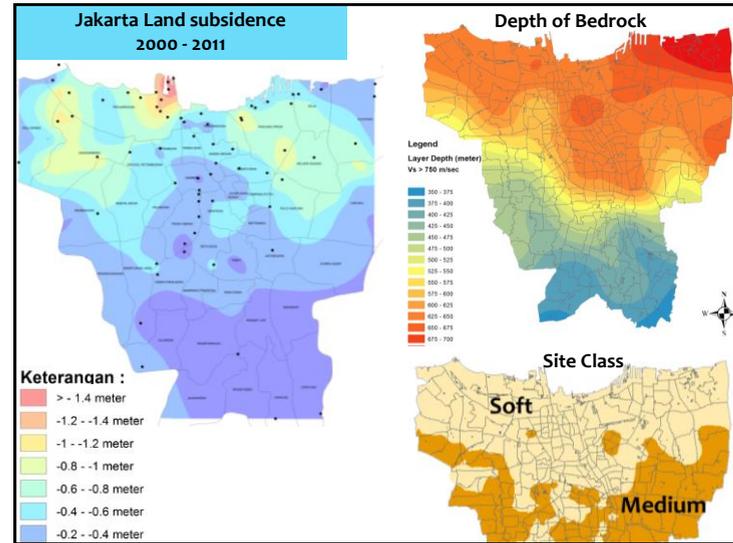
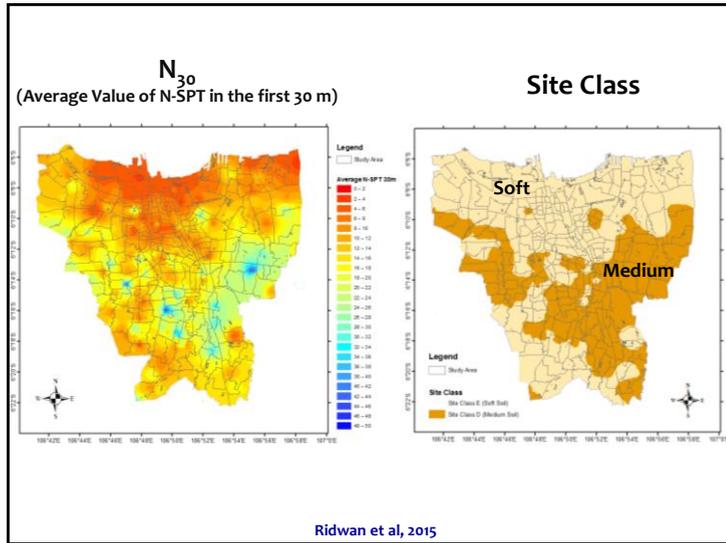
By Human Activity:

1. Soft soil (15-25m) consolidation due to surcharge load from Fill / Embankment / Reclamation
2. Deeper clay consolidation due to surcharge load from high rise buildings
3. Extraction of groundwater excessively

By Nature:

1. Natural compaction of soil, due to underconsolidated soil layer (Hutasoit, 2012)  
Possibly due to secondary consolidation from overburden pressure
2. Settlement due to tectonic activity (geologists)
3. Sea water rise due to Global Warming (effect to inundation)





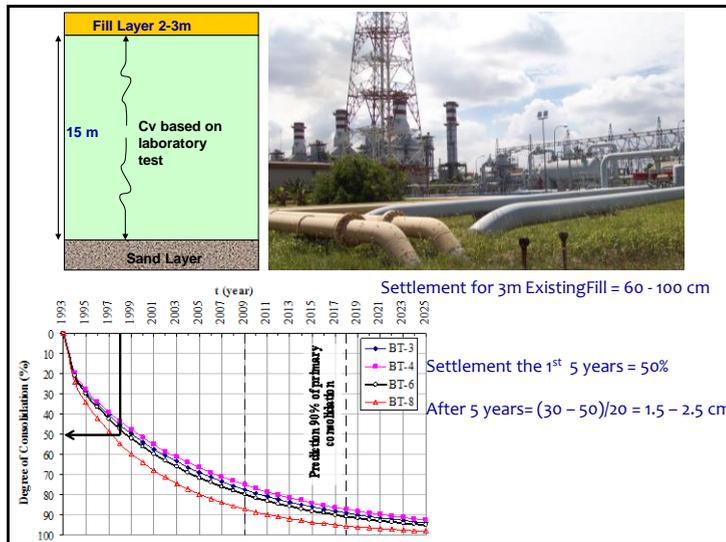
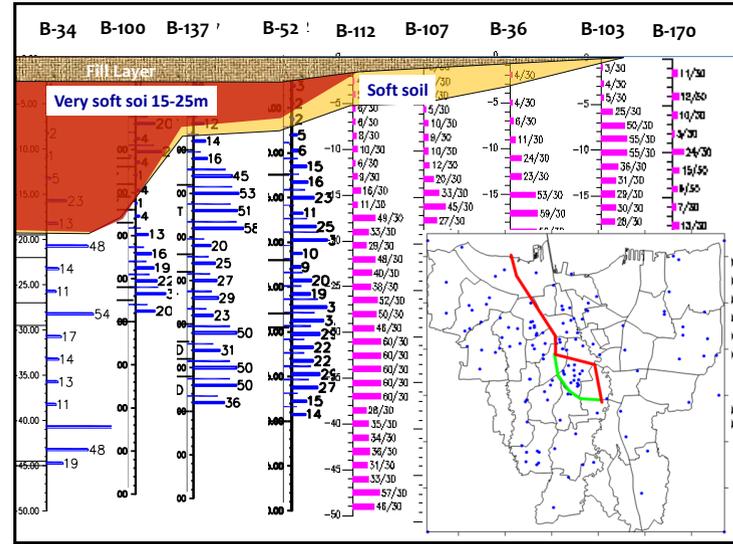
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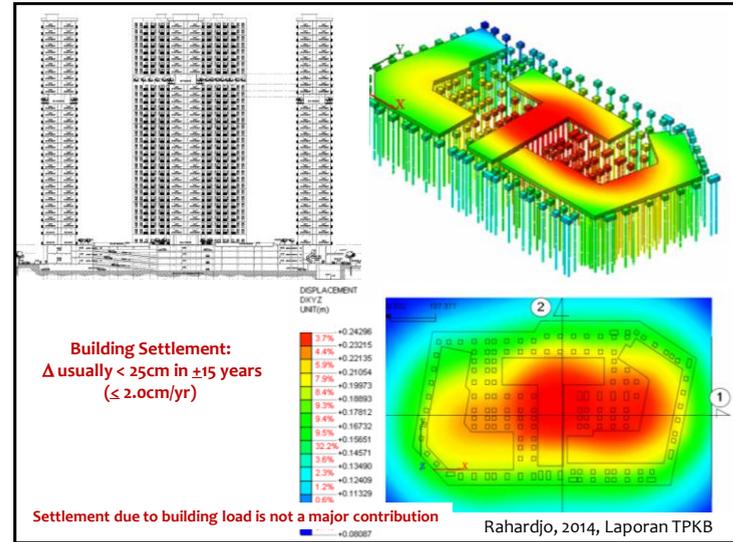
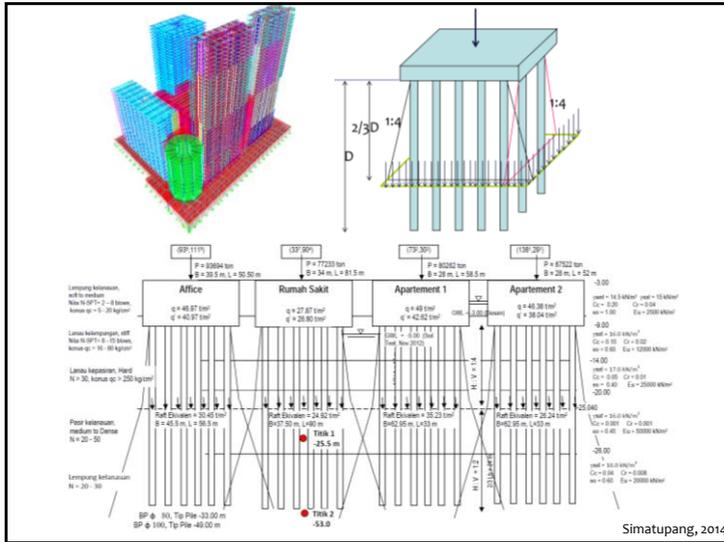
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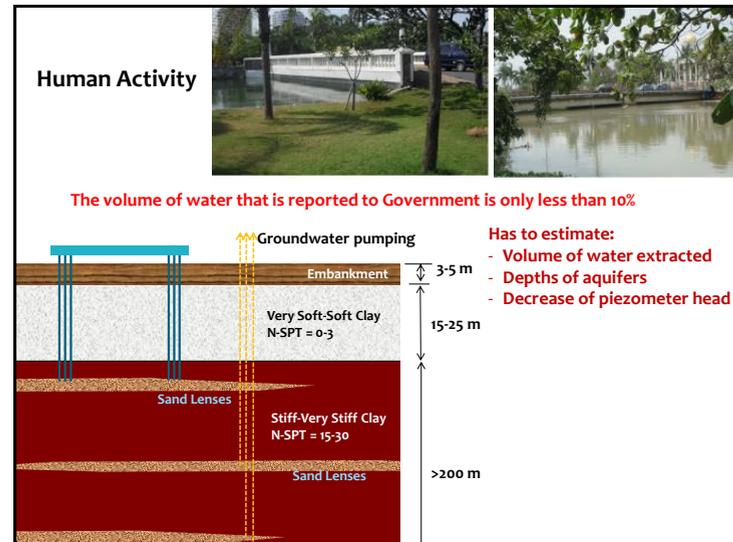
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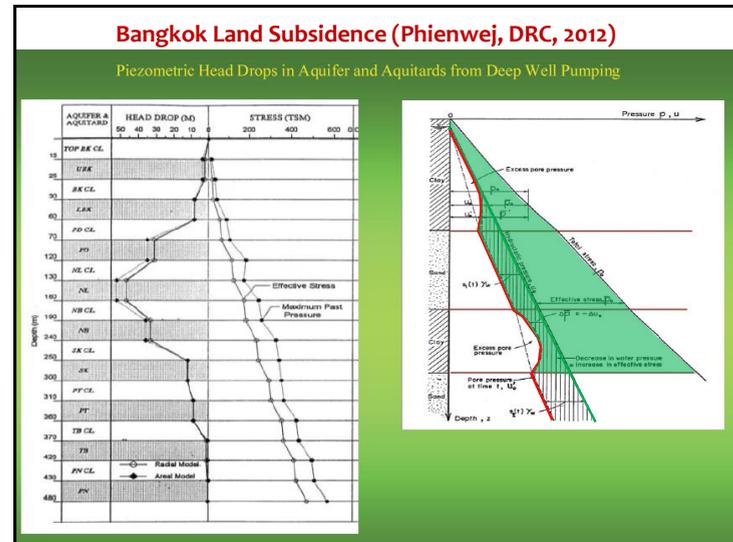
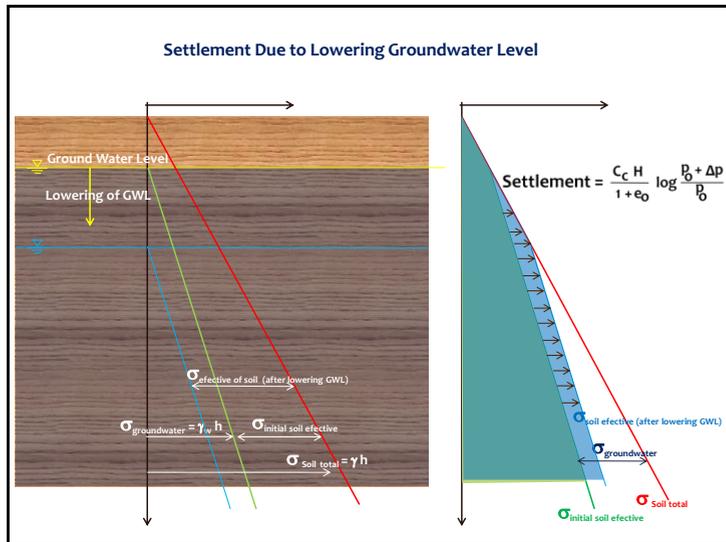
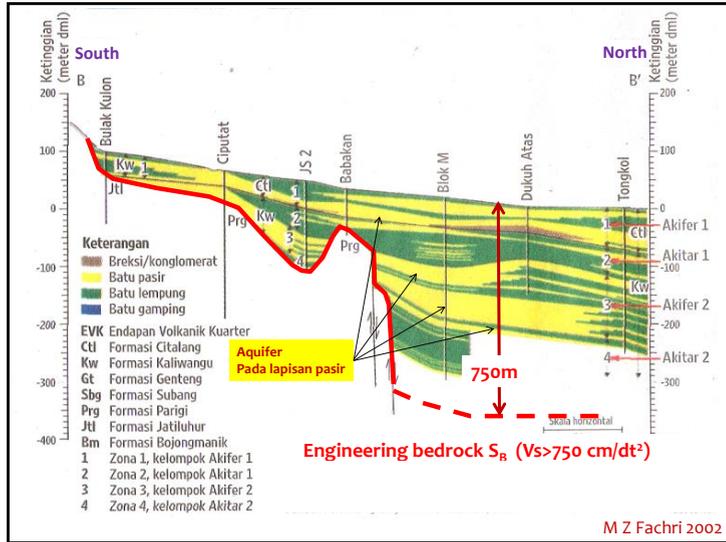
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**4. Results** **HITACHI**  
Inspire the Next

Choosing area for groundwater extraction by land use  
-Distributing the extracted groundwater to industrial and commercial area.

**Area for groundwater extraction (Estimated)**

- Commercial and Institutional Area
- Industrial Area
- Other
- Residential Area

Source: The Simulation Study on Climate Change in Jakarta, Indonesia, JICA 2012

**Correlation between land use and land subsidence**

Source: Hasanuddin Z. Abidin Report

Fig-4.2 Accumulation subsidence quantity 1974-2010      Fig-4.1 Land use 2007

We assume that major groundwater extractions were occurred in commercial and industrial areas mainly. The map shows land subsidence occurs in these areas.

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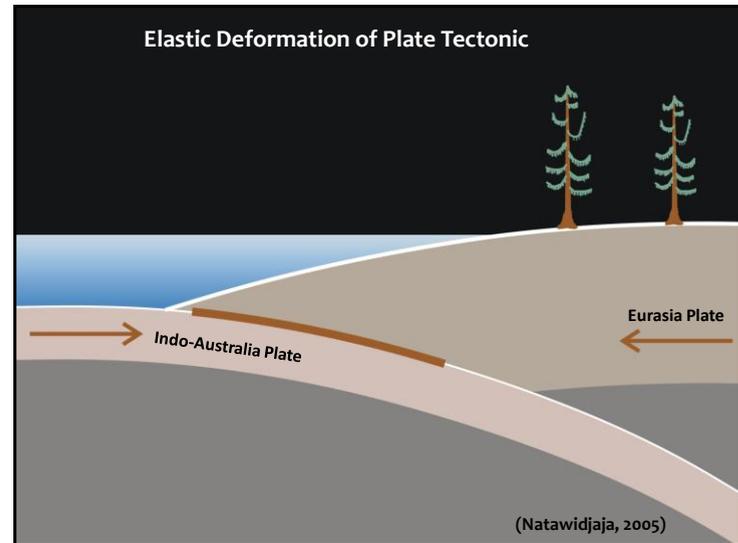
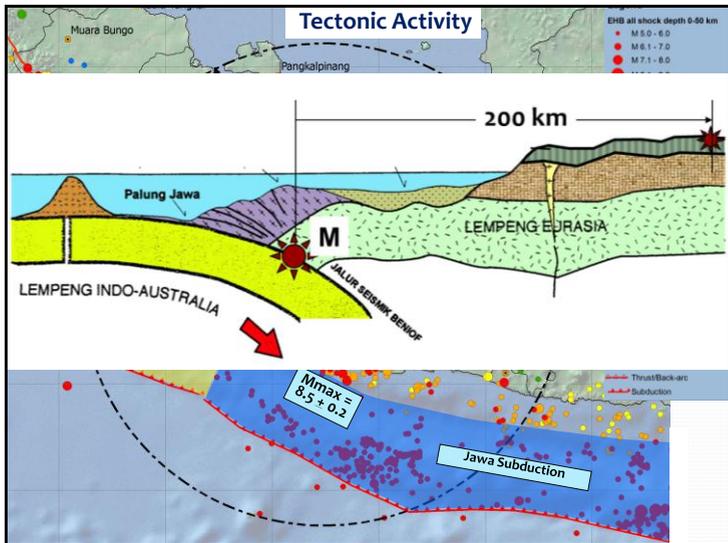
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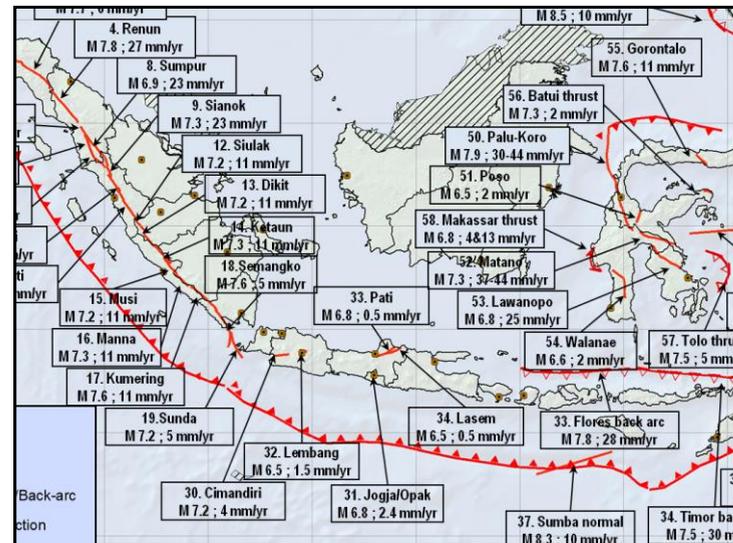
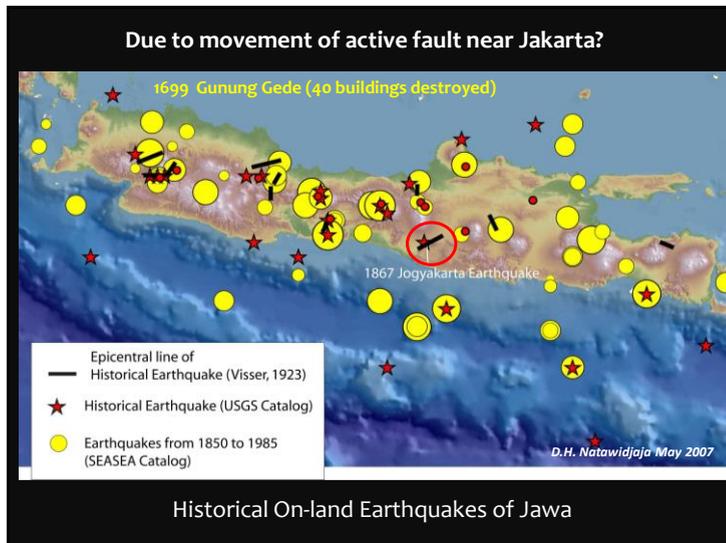
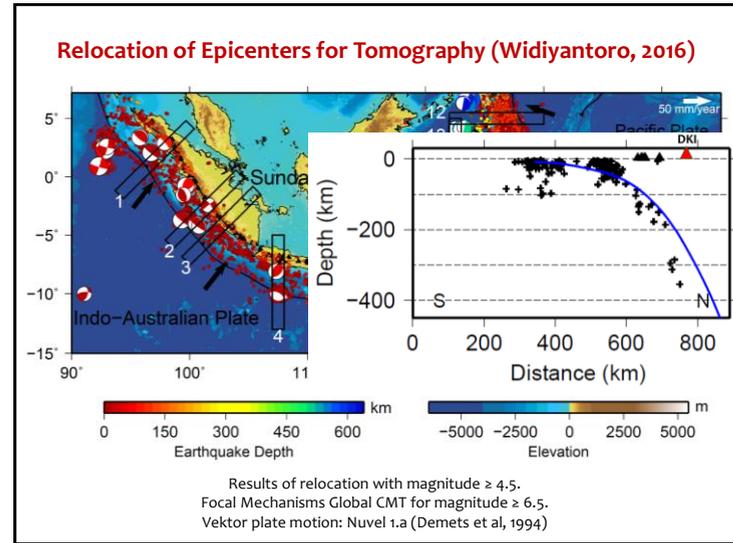
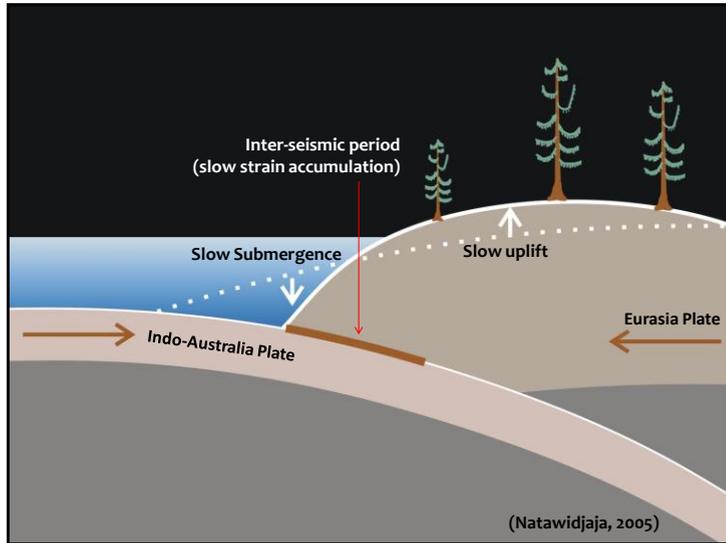
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## Predicsted Causes of Land Subsidence

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2. Settlement due to tectonic activity (geologists)
3. **Sea water rise due to Global Warming (effect to inundation) = 0.8 cm/year**

## Predicted Causes and Contributions (Irsyam, 2015)

Cause	Contribution
High rise buildings	1.0 cm/year (10%)
Existing Fill/ Embankment/ Land reclamation	1.5-5.0 cm/year (20-50%)
Water extraction	4.0-6.0 cm/year (40-70%)
Tectonic activity	Unclear
Sea water rise	0.8 cm/year (10%)

**17% (Hutasoit, 2015)**

**Verification of Predicted Causes and Contributions MUST BE CONDUCTED**  
**Field measurement is NO REGRET STRATEGY**

## Content:

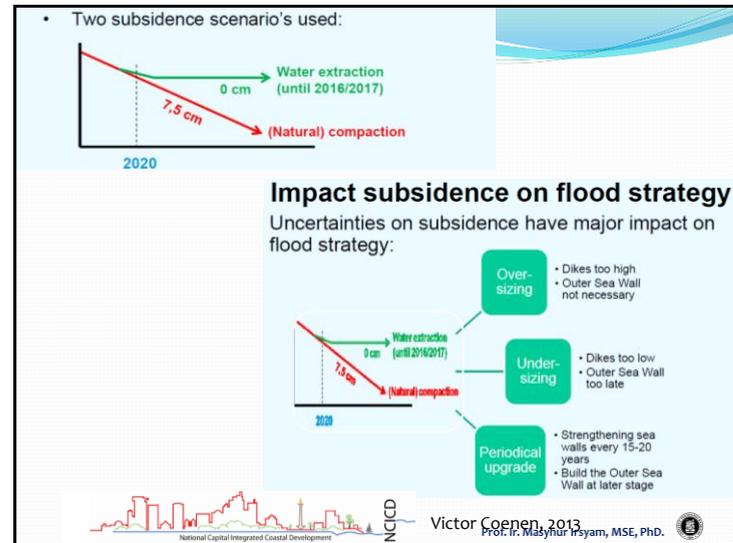
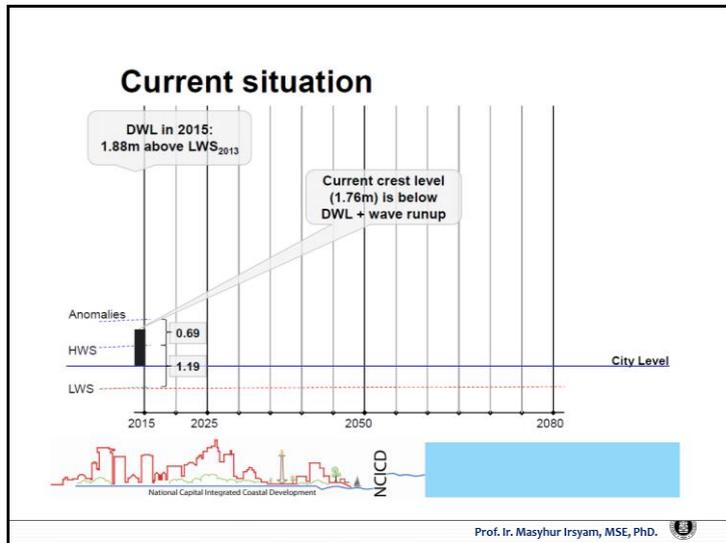
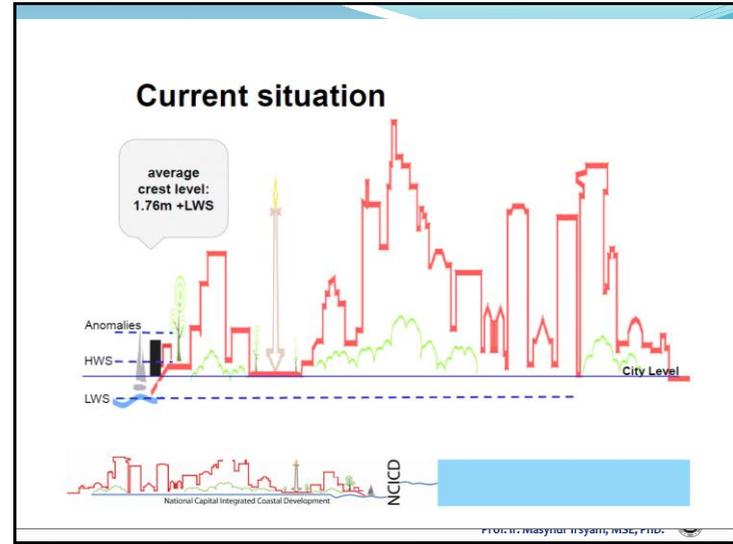
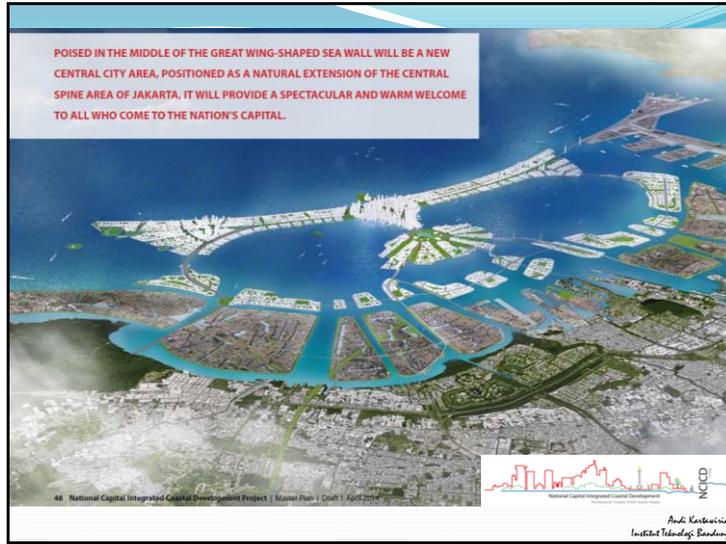
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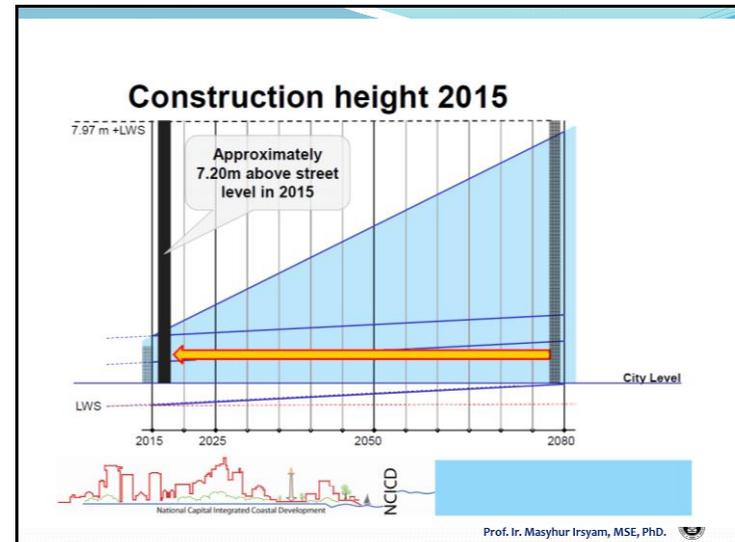
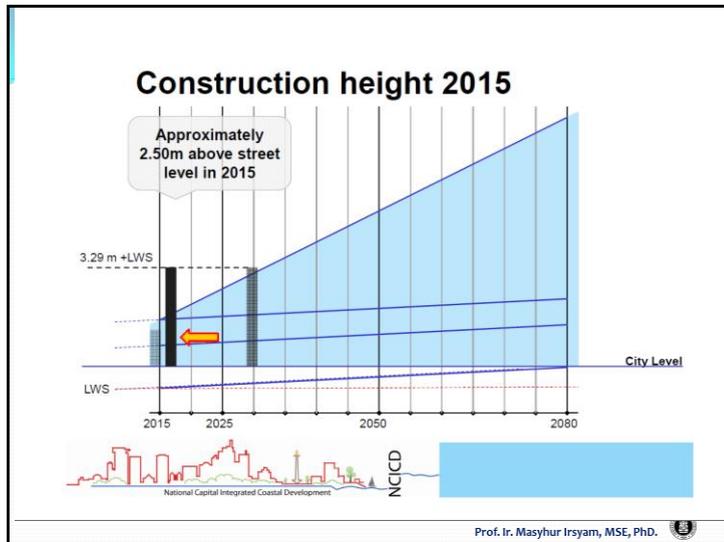
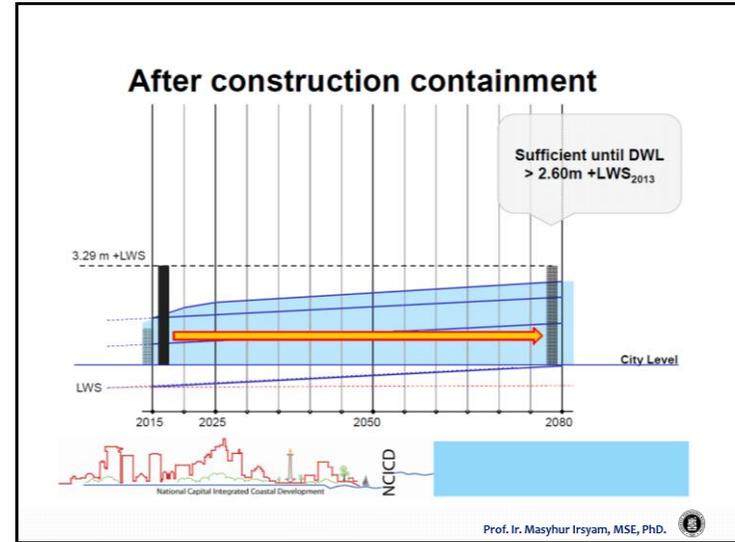
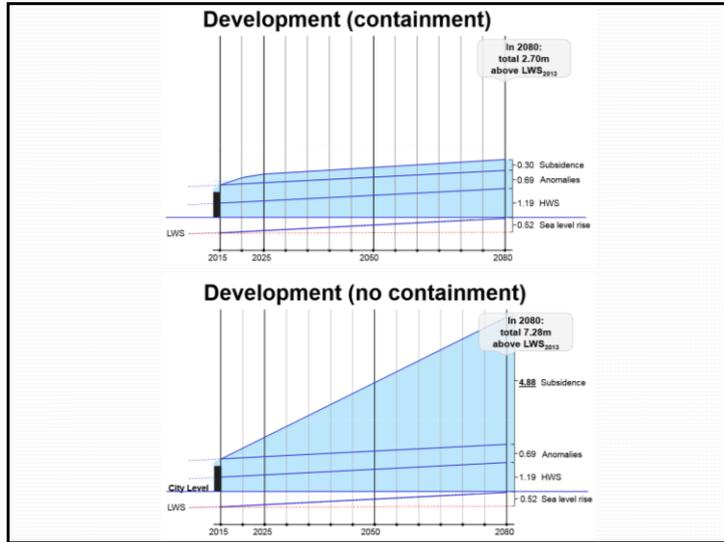
## Government Strategy for Jakarta

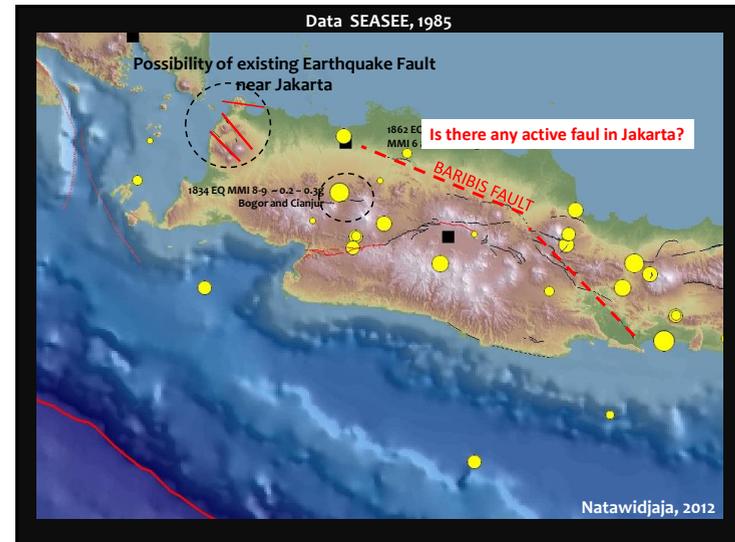
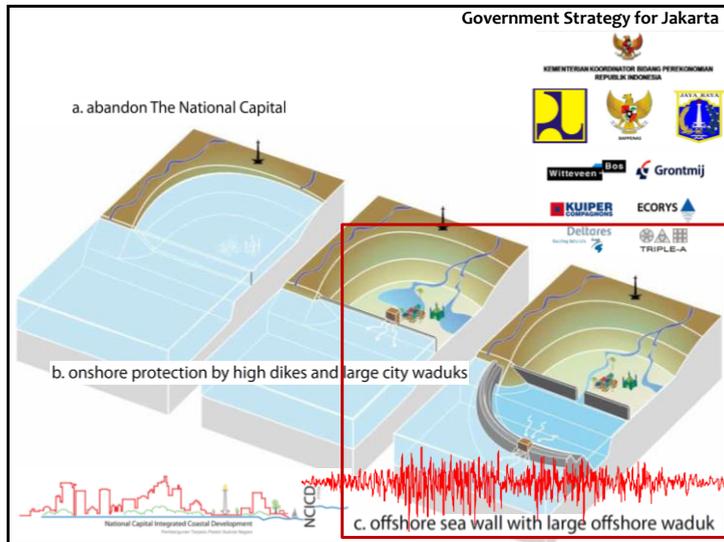
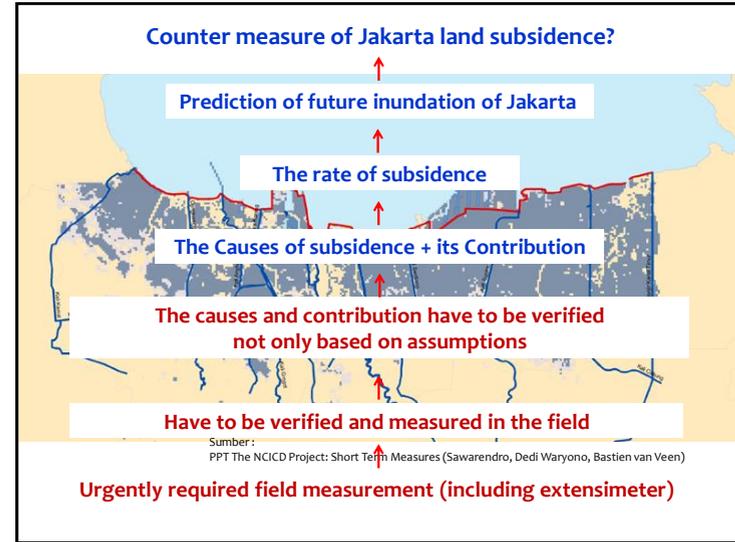
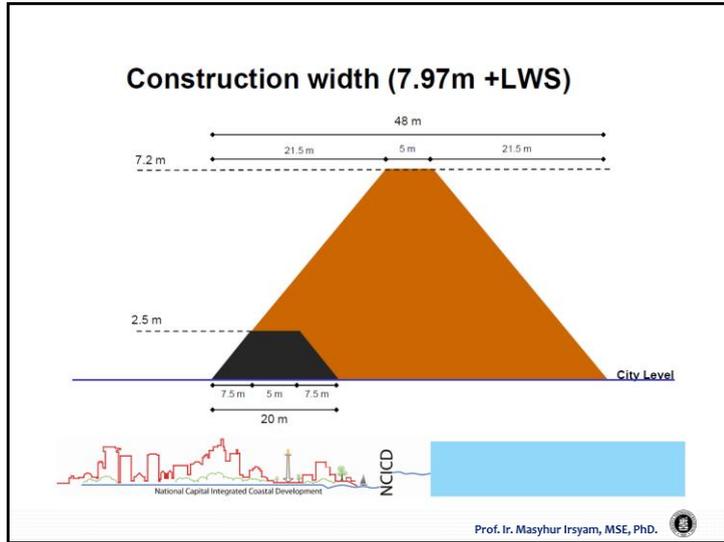
### Three principal solutions:

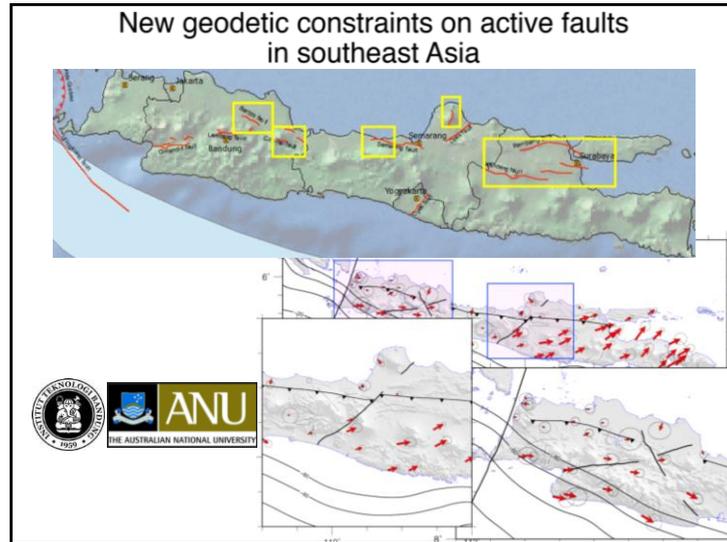
- a. abandon The National Capital
- b. onshore protection by high dikes and large city waduks
- c. offshore sea wall with large offshore waduk

National Capital Integrated Coastal Development (NICCD)









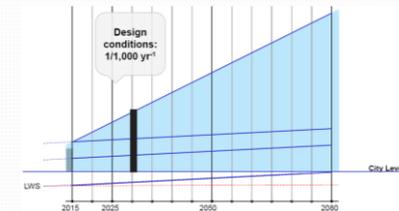
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### Fundamental Issues for NCICD (from Geotechnical Engineering perspective)

- What are the causes and their contributions of subsidence?
- Why the rate of subsidence increase?
- What is the rate of subsidence appropriate for design?
- What to do to decrease or stop the subsidence?
- Is there any active fault crossing Jakarta?

**Sebaiknya dijawab dahulu pertanyaan2 ini sebelum dilakukan perencanaan/ pelaksanaan lanjut**



- Giant Sea Wall is designed to accommodate land subsidence in 65 years
- This wall is calculated based on assumption that the rate of settlement is 7.5cm/year  
**This assumption has to be verified**
- In addition,  
Construction of giant sea wall does not solve the land subsidence phenomena, only buys time  
→ cause of problem itself has also to be solved



### Urgent Actions:

- Continuous monitoring ground surface settlement by using advance methods
- Monitoring subsurface and distribution of settlement below ground surface by installing extensometer and piezometer
- Assessing the amount of water that is pumped and location of aquifers
- Obtaining soil properties by performing deep boring
- Estimating rate of settlement based on geologic and geotechnic investigation verified by result of surface and subsurface monitorings.



### Recommended appropriate measures

#### Policy:

- Providing clean water supply for Jakarta and stopping the deep groundwater abstraction
- The Government should take the lead and stop the deep groundwater abstraction (replace by PDAM) in all Government and Public buildings.
- Charge for using groundwater and check amount of the groundwater usage
- Establishing a taskforce concentrate to handle subsidence of Jakarta