Capabilities and Constraints of Geodetic Techniques for Monitoring Land Subsidence in the Urban Areas of Indonesia

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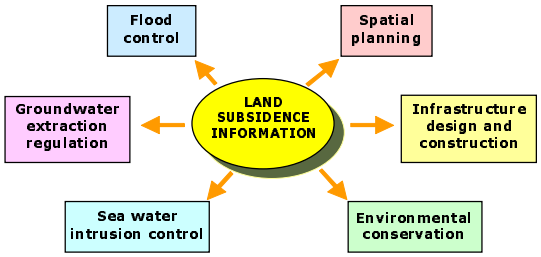
Land Subsidence in Indonesian Cities

Observed land subsidence :
- Jakarta
- Bandung
- Semarang

Expected land subsidence :
- Surabaya
- Denpasar
- Cilegon
- Medan

observed decrease in groundwater level

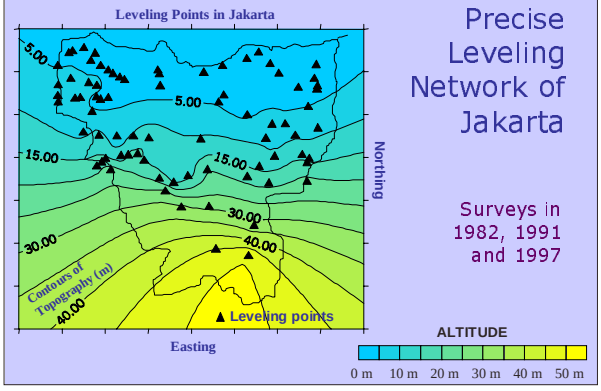
IMPORTANCE OF LAND SUBSIDENCE INFORMATION



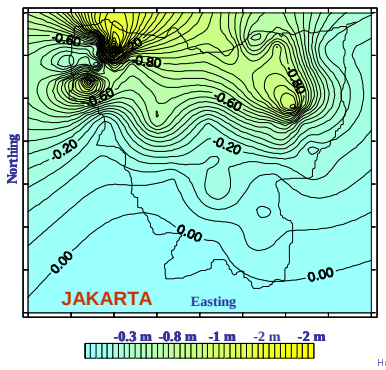
(GEODETIC) MONITORING OF LAND SUBSIDENCE

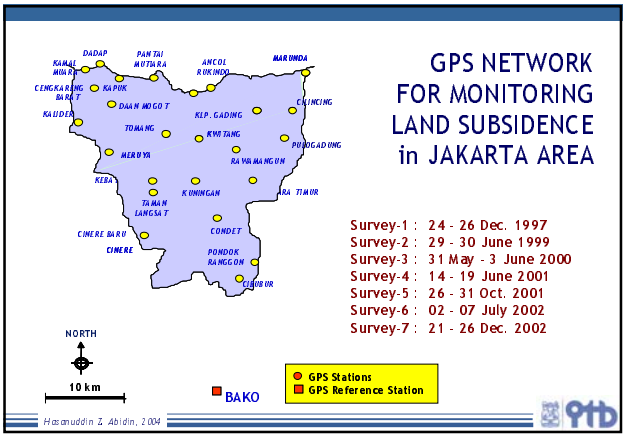
Three geodetic techniques have been utilized to monitor land subsidnece in a few urban areas in Indonesia : Leveling, GPS Survey and InSAR

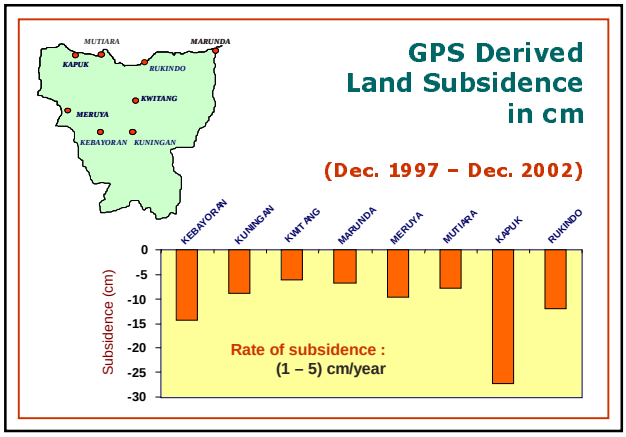
Geodetic Technique	Jakarta	Bandung	Semarang
Leveling	Yes	No	Yes
GPS Survey	Yes	Yes	No
InSAR	Yes (Preliminary)	No	No

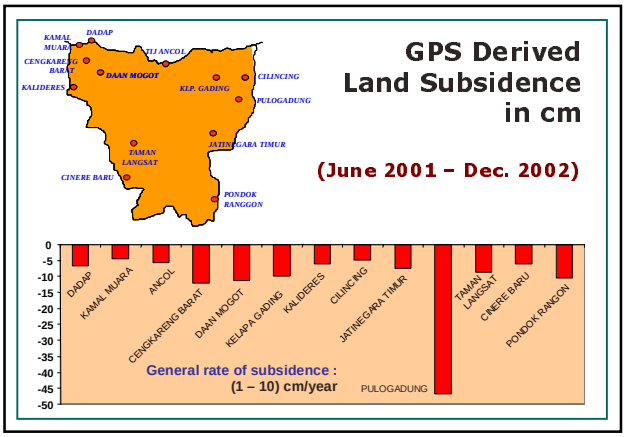


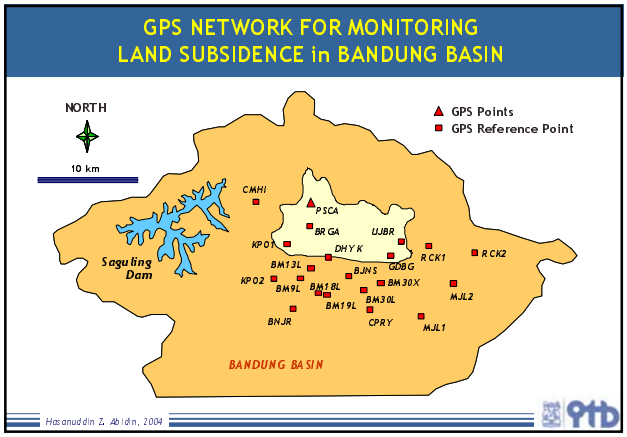
Land Subsidence from Leveling, 1982 - 1997

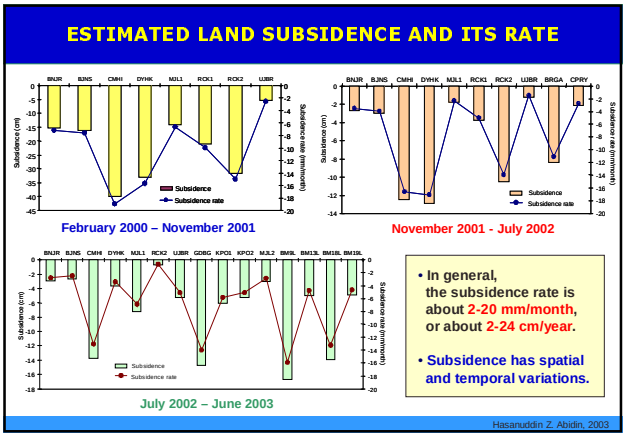


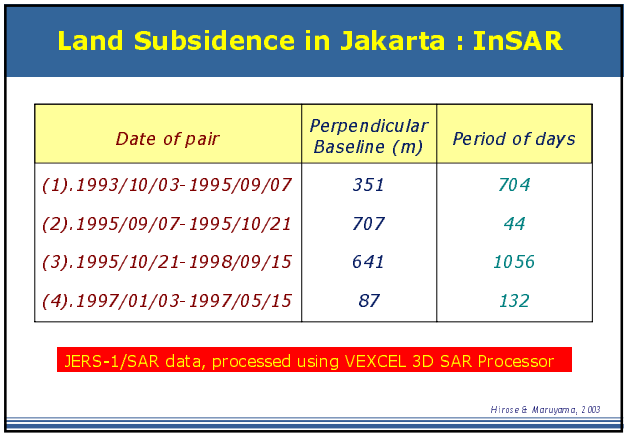






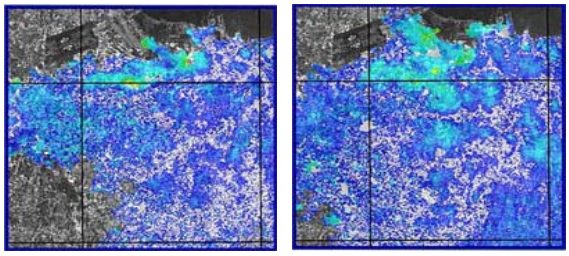






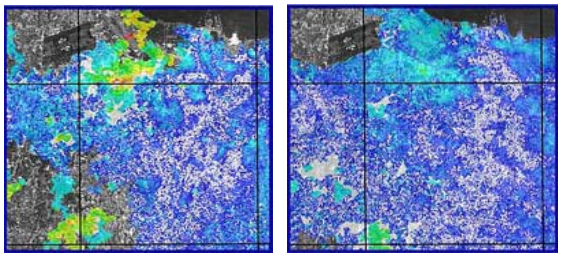
Date of pair	Perpendicular Baseline (m)	Period of days
(1).1993/10/03-1995/09/07	351	704
(2).1995/09/07-1995/10/21	707	44
(3).1995/10/21-1998/09/15	641	1056
(4).1997/01/03-1997/05/15	87	132

Result of InSAR Processing (1)



Hirose & Maruyama, 2003

Result of InSAR Processing (2)



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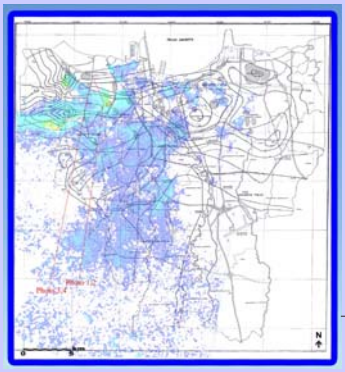

Annual Subsidence Rates from InSAR

10 cm/year (1993-95)
6 cm/year (1995-98)

Good correspondence with the results from Leveling and GPS Surveys.

Leveling (1982-1997) and InSAR results.

Hirose & Maruyama, 2003

Leveling Technique

STRENGTHS

- very precise height differences.
- can flexibly handle a relatively dense and crowded urban area.
- benchmarks can also be easily located.
- data processing is not complicated.

CONTRAINTS

- relatively slow and time consuming in its execution.
- dependent on time, weather and also condition of traffic and human activities along the leveling routes.
- connection to to the stable benchmark ?

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GPS Survey Technique

STRENGTHS

- unique datum → effective to monitor land subsidence in a relatively large area;
- relatively consistent precision in temporal and spatial domain.
- more flexible field operation (day and night, independent of weather condition)

CONTRAINTS

- signal obstructions and/or multipath caused by high rise building, housing, trees and/or billboards.
- development activities inside the urban areas which sometimes destroy or alter the observation monuments.
- precise data processing skill is required.

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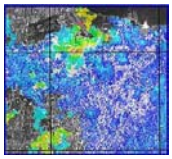
InSAR Technique



STRENGTHS

- provide accurate subsidence information on a more continuous spatial domain.
- can give more insights into characteristics of subsidence phenomena in a regional sense.
- more Radar satellites on space.

CONTRAINTS

- required radar images, processing software and expertise to process the images.
- time frames for studying land subsidence ?
- dense vegetation and dynamic atmospheric condition ?

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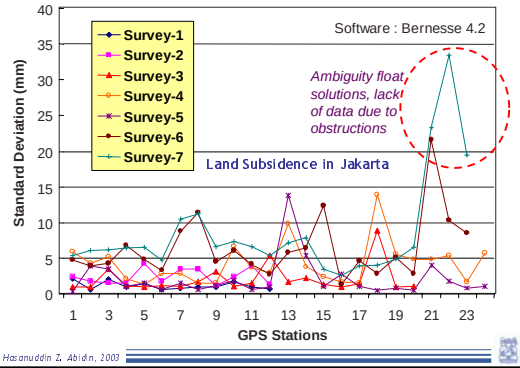
Closing Remarks

Many things still have to be done

for studying and monitoring
land subsidence phenomena
in the urban areas of Indonesia

RMS of Differential Ellipsoidal Heights (dh)



STANDARD DEVIATIONS OF ESTIMATED ELLIPSOIDAL HEIGHTS