Subsidence in central Mexico and western Indonesia: differences and similitudes from regional ALOS-time series surveys

Abstract

We use InSAR SB time series analysis of 1600 ALOS data to provide a regional picture of the land subsidence problem in central Mexico and western Indonesia.

In Mexico subtraction is observed in 25 areas, including 17 cities, at rates up to 30 cm/yr, in 9 areas, including 6 cities.

Veelosity maps combined with land use and surface geology mapping reveal that:

1. In Mexico agricultural groundwater extraction participates in cause of rapid subsidence, while in Indonesia it is industrial groundwater pumping.

2. In Mexico the subsiding areas are characterized by high velocity gradients coinciding with existing faults, while in Indonesia the gradients are linear and no matched faults exist.

3. In both locations subsidence is linear with very small seasonal variability.

Regional surveys provide critical information for efficient use of ground-based monitoring, characterization of aquifer systems properties, important to reach sustainable groundwater use, and development of hazard mitigation plans.

Comparison between subsidence in Mexico and Indonesia

Subsidence in central Mexico

- Averaged 2007-2011 ground velocity map: Black boxes and meets subsiding sites
- 2-D Velocity field in Mexico City: motion is mostly vertical, Brown lines, surface geology: 1: incompressible, 2: compressible, 3: intermediate deposits, red lines faults.

Subsidence in western Indonesia

- Averaged 2007-2009 velocity map and zoom in the 9 subsiding areas, including 6 industrial areas (only 3 sites previously documented)

Method and workflow

- Data: 1600-2007 ALOS SAR images
- D-InSAR processing (~600 interferograms produced with ROI_PAC)
- Time series: Small Baseline method (SB)
- Delaunay triangulation, small spatial & temporal baselines (<1.5 km & 1 year, respectively)
- Coherence threshold of 0.5

- Remove planes, Check closure, Perform D-InSAR, Error correction
- Vertical and horizontal displacements retrieved from ascending and descending in Mexico City (Wright et al., 2004); LOS motion converted in vertical elsewhere.

Subsidence will cause
- Large-scale flooding from ocean
- Rapid subsidence leads to increased frequency and spatial extent of landslides
- Major associated hazard: high velocity gradients observed in subsiding areas
- High risk of future flooding
- High risk of future collapse
- Groundwater and gas extraction are likely responsible for rapid subsidence in Indonesia.

High velocity gradients in all locations in ~10 cm yr-1

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