

## SUBSIDENCE I (35)

## I Main Topics

- A Recognition of subsidence hazards (Case histories)
- B Characterization of subsidence hazards
- C Evaluation of subsidence hazards (Subsidence mechanics)
- D Assessment and mitigation of subsidence hazards

## II Recognition of subsidence hazards

<http://water.wr.usgs.gov/sub/>

<http://water.usgs.gov/pubs/circ/circ1182/>

<http://www.env.go.jp/en/soe/ground.html>

<http://books.nap.edu/books/POD309/html/45.html>

## A Distribution of hazard

- 1 World-wide: see highly incomplete distribution below
- 2 U.S.
  - a >44,000 km<sup>2</sup> (See Figure 1 from Panel on Land Subsidence)
  - b \$125 million annually (as of 1991)

## B Fluid withdrawal from porous media

<http://geo0.eng.morgan.edu/center/gallery-hazarWD.html>

- 1 Extraction of oil and gas (e.g., Long Beach, CA; Niigata, Japan)
- 2 Extraction of geothermal fluids
  - a Wairakei, NZ. 4.5m subsidence 1964-1975
  - b The Geysers, CA. 13 cm subsidence 1973-1977
- 3 Extraction of ground water (e.g., Tokyo; Mexico City; Venice; Santa Clara and San Joaquin Valleys, CA; Houston, TX)

## C Subsidence of organic soils

(e.g., Mississippi river Delta; Everglades, FL; Sacramento Delta, CA)

- 1 Magnitude: near 10 meters in the 20<sup>th</sup> century near Sacramento
- 2 Causes
  - a Void loss due to water withdrawal
  - b Compaction due to plowing
  - c Wind (and water) erosion
  - d Burning
  - e Biochemical oxidation