



## Preface: Prevention and mitigation of natural and anthropogenic hazards due to land subsidence

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An awareness of problems related to land subsidence and its anthropogenic causes has been growing worldwide since the second half of the Twentieth century. The problem of land subsidence was first included by the UNESCO program of the International Hydrological Decade (IHD), 1965–74. In 1969 UNESCO convened the 1st International Symposium on Land Subsidence in Tokyo. In 1975 land subsidence was retained under the framework of the International Hydrological Program (IHP) as subproject 8.4 “Investigation of Land Subsidence due to Groundwater Exploitation”, and UNESCO IHP formally codified the Working Group on Land Subsidence. In collaboration with UNESCO IHP, IAHS, and other scientific organizations, the UNESCO–IHP Working Group on Land Subsidence convened eight more International Symposia on Land Subsidence in different countries in Asia, Europe and North America: Anaheim, USA (1976); Venice, Italy (1984); Houston, USA (1991); The Hague, Netherlands (1995); Ravenna, Italy (2000); Shanghai, China (2005); Queretaro, Mexico (2010); and Nagoya, Japan (2015).

Though subsidence is a global phenomenon, the consequences and their remediation generally are local. Land subsidence has become an important area of research in Japan, and globally. The proceedings of the Ninth International Symposium on Land Subsidence (NISOLS, Nagoya, 2015) represents a body of high quality and globally relevant scientific and technical information for scientists, engineers, and other stakeholders concerned about land subsidence and the associated hazards. The papers in this volume cover international science and social issues related to land subsidence and the role of natural resources development.

The main topics addressed by NISOLS includes Land Subsidence processes related to (1) Aquifer-system compaction and subsidence caused by groundwater withdrawal,

(2) Risk management of subsidence related hazards, (3) Anthropogenic land subsidence in coastal regions, (4) Land subsidence related to soil oxidation, (5) Anthropogenic uplift (CO<sub>2</sub>-sequestration included), (6) Land subsidence and liquefaction, due to the East Japan Great Earthquake of March 11, 2011, (7) Ground failure (fracturing, fault activation, fissuring), (8) Land surface displacement, measuring and monitoring, (9) Numerical modelling, (10) Social, cultural and economic influence of land subsidence, (11) Water management strategies, (12) Subsurface deformation due to shale gas production, (13) Settlements and geotechnical construction activities and (14) Seismic activity, triggered by fluid extraction and injections. Many presenters describe the development of new techniques for monitoring, analysis, interpretation and prediction of subsidence and (or) related fracturing processes – an emphasis of NISOLS.

This symposium and the proceedings are of particular interest for Japan because of the close relation between land subsidence, ground fracturing, and groundwater use and management. These phenomena provoke widespread problems in the rapidly growing urbanized areas of central Japan. The analysis of these phenomena requires a multidisciplinary approach to improve understanding of the triggering factors, failure modes, and propagation processes of fracturing. Resolution of the often conflicting socio-economic demands placed on our natural resources and the desires to protect and preserve our natural resources is an inevitable condition for the sustainable development in developed areas. To face this challenge in Japan and elsewhere we need to improve our understanding of Land Subsidence processes. An effort was made in NISOLS to integrate a broad spectrum of the subsidence-interest community; three peripheral technical meetings were convened to focus on subsidence-related topics: (1) Workshop on Subsidence Monitoring, (2) Work-

shop on MODFLOW Subsidence Simulation, and (3) Workshop on Geotechnical Databases.

On behalf of Inter Group Corporation, Daido University and the UNESCO-IHP Working Group on Land Subsidence we are pleased to present the proceedings of NISOLS 2015 and hope that you find much relevant and useful information in the contributed papers.

### Acknowledgements

The Organizing Committee is grateful to the many people who gave their time, effort and knowledge to produce a successful program, productive workshops and enjoyable field trips. The Scientific Advisory Board diligently peer reviewed each of the contributed abstracts and papers. The Local Organizing Committee accomplished the overwhelming tasks of arranging, coordinating, directing and hosting the symposium and processing the contributed abstracts, presentations and papers.

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