Preface:

Developments in land subsidence investigation

These proceedings compile the papers that were submitted to the Eighth International Symposium on Land Subsidence (EISOLS), and represent an overview of the state of the art in the investigations of land subsidence around the world. One of the main accomplishments of EISOLS has been the production of this volume with a considerable amount of high quality scientific papers. Because many major subsidence areas occur along the coast in rapidly developing countries with increasing demands for groundwater, oil and gas the previous seven Symposia on Land Subsidence have attracted attention to major subsidence areas along coastal areas in the world, such as Tokyo in Japan (1969; elevation 35 m), Anaheim in the USA (1976; elevation 66 m), Venice in Italy (1984; elevation 5 m), Houston in the USA (1991; elevation 15 m), The Hague in The Netherlands (1995; elevation 4 m), Ravenna in Italy (2000; elevation –1 m), and Shanghai in China (2005; elevation 6 m). EISOLS follows the tradition of the previous symposia but with an added focus on subsidence in inland areas, such as in and near Querétaro, Mexico (2010, elevation 1820 m), the host city.

In recent years considerable multidisciplinary research effort has been expended in attempts to describe the complex nature of the phenomena related to land subsidence, which is caused either naturally or anthropogenically. The multidisciplinary focus on these processes is critically needed and will play an important role in the development of resource management strategies addressing the impacts of climatic change and the means to achieve sustainable urban environments and optimal use of the land and water resources. Although the problem is global in the sense that it affects major urban centres and engineering facilities (mining, water distribution and storage, railroads and ports, among others) worldwide, the mitigation and solution for each case demands knowledge of the local geological, hydrogeological, mechanical, and morphological characteristics of the areas affected. The new advances in these multidisciplinary studies show the growing need to incorporate new views in planning of urban development, in legal frameworks, the related social problems and environmental damages, monuments heritage, and urban risk analysis.

The papers in Section 1 of this book examine the mechanisms of earth fissures and fracturing induced mainly by groundwater pumping, a widespread problem in central Mexico. Case studies from Mexico and the USA are presented, as well as different methodologies for characterization and monitoring of fracturing. The improvement of numerical methods, including nonlinear analysis, thermo-poro-elastic criteria, and analytical solutions considering poro-elastic media, are presented in Section 2. The papers in this section evaluate models of land subsidence caused by groundwater and gas extraction in Italy, USA, China, Mexico, The Netherlands, Japan, and Poland. One contribution examines the thermo-mechanical effects of seawater injection for reversing subsidence. Advances in computer capabilities have led to achievements of recent years in modelling and simulation of geological system deformation caused by fluid or gas depletion and their associated hazards, allowing the specialists to couple the geomechanical and hydraulic behaviour, and to consider subsoil heterogeneities. In Section 3, geological and geomechanical processes associated with land subsidence are addressed. Most of these contributions are by Mexican scientists, and document ground fracturing in cities such as: Morelia, Querétaro, San Luis Potosí, Aguascalientes, Jalisco, Zacatecas, Mexico City and Pachuca. Case studies from The Netherlands, Spain and Iran also are presented. The geomechanical behaviour of clayey materials from Paris and Mexico City are discussed, as are some geotechnical aspects of mining and construction in China. The papers in Section 4 document notable advances in techniques for measuring and monitoring ground displacements using remote sensing (InSAR) and new methods for processing satellite data to improve temporal and spatial resolution (DInSAR, PSI, PInSAR). The reported case studies include those from: Venice, Bologna, Emilia Romagna and Crotone regions in Italy; California, USA; Mexico City, Mexicali, Baja California and Morelia in Mexico, Catalonia, Spain; Java, Indonesia; the Canto Basin and Kujukuri plain in Japan; Iran, India and China. In situ Global Positioning System and extensometer monitoring strongly support some of the studies. Alarm
systems are being developed at some of the sites mentioned. Section 5 provides a set of papers discussing the social and economic impact of land subsidence and the need to incorporate a legal framework in public policies and resources management. Specialists from The Netherlands, Italy, USA and China document examples of subsidence management, and works from Mexico establish the need to consider the legal implications of environmental and urban damage caused by land subsidence and fracturing associated with excessive groundwater exploitation. Specific studies of strategic techniques for the assessment of urban risk in Mexico and Poland also are included. The papers in Section 6 deal with the problem of fluids withdrawal (gas and water) and provide simulations of subsidence for different extraction scenarios. The results and implications related to climate change are presented by scientists from Canada, USA, China and Mexico.

Analysis of the subsidence research presented in the EISOLS leads to reflection on the state of the art of the subject world-wide. The studies of land subsidence from around the world highlight the difference in the development of analytical and monitoring techniques used to assess the related risks, and reflect the various socio-economic activities contributing to the phenomena in each country. EISOLS provided an important opportunity to document and review the problems in Mexico. A special effort is needed to integrate efforts of the many scientists and other specialists working on this subject in Mexico and to coordinate academic issues with government agencies dealing with resources management. An accurate assessment of risk and environmental damage should support the planning of urban development in the increasingly populous cities of central Mexico. The absence of contributed research from other Latin America countries is noted; perhaps the problems are not as common as in Mexico. A few case studies of subsidence caused by salt and carbonate dissolution have been reported in Argentina and Cuba, and a study from Guatemala recently reported the case of sinkholes related to collapsible materials. Though the exploitation of gas and oil in the eastern part of Mexico and in Venezuela certainly are accompanied by important ground deformation consequences, the impacts largely are under-reported.

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The EISOLS is an opportunity and an important means for the international land subsidence community to exchange ideas, developments and experience. We sincerely hope that EISOLS will benefit academicians and professional practitioners interested in subsidence processes and related issues. We thank those who came to Querétaro from around the world to share their expertise, and look forward to meeting again with you and even more colleagues from other countries at the future Ninth International Symposium on Land Subsidence.

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