Preface

Since the start of hydrocarbon production in the Netherlands, measurement campaigns have been performed to measure the resulting subsidence, to which gas and oil companies in the Netherlands are legally obliged. The majority of the gas fields in the Netherlands, including the Groningen gas field, are operated by Nederlandse Aardolie Maatschappij B.V. (NAM). Different subsidence measurement techniques (leveling, GPS) have been utilized since the 1960s. Synchronously, geodetic estimation methodologies have been developed to estimate subsidence due to hydrocarbon production from the measurements, in which the Delft Institute of Earth Observation and Space Systems (DEOS) has been closely involved. Since the 1990s, satellite radar interferometry (InSAR) as a deformation monitoring technique has developed. However, the situation in the Groningen area is challenging (temporal decorrelation, rural areas, atmospheric disturbances, small deformation rates—several mm/year—over a large spatial extent). In 2003, the project 'Fundamenteel Onderzoek Radar Interferometrie' was approved (Regeling Technologische Samenwerking), which enabled a four year PhD research to investigate the feasibility of InSAR for monitoring subsidence due to hydrocarbon production, in cooperation between Delft University of Technology and NAM. This book describes the results of this scientific research, that is directly coupled to the practical demand for subsidence monitoring techniques. It covers the topic in a generic way: both precision and reliability of InSAR as a measurement technique and the estimation of earth surface deformation in the presence of multiple deformation causes are addressed.

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Audience

The research described in this book investigates the applicability of satellite radar interferometry (InSAR) for deformation monitoring, in particular subsidence due to hydrocarbon extraction. It covers the subject in a generic way, from the precision and reliability of InSAR as a measurement technique to the estimation of the deformation signal of interest in the potential presence of multiple deformation causes. It provides an overview of the Persistent Scatterer InSAR (PSI) theory, and subsequently focuses on the accuracy of the parameter estimates. For the reliability assessment of InSAR deformation estimates, which is essential for operational use, the multi-track datum connection procedure is introduced. The presented methodologies are demonstrated in an integrated way for the entire northern part of the Netherlands and a part of Germany (covering $\sim$15.000 km^2) using time series of ERS and Envisat acquisitions. The capabilities of PSI for wide-scale monitoring of subsidence rates of several millimeters per year in rural areas are shown. Furthermore, it is demonstrated that the temporal observation density of PSI improves the insight in hydrocarbon reservoir behavior. The reader is assumed to have a background in geosciences and to be familiar with basic radar interferometry concepts. The book is designed for both researchers and the industry, since it translates the research results into the consequences for the operational use of InSAR for subsidence monitoring.

Readers who are interested in a geological background of the Groningen gas reservoir and the prediction of subsidence at ground level are referred to Chap. 2. For the theoretical background of PSI and its precision and reliability, the reader is recommended to focus on the Chaps. 3, 4, and 5. If one has a background in PSI and is looking for the specific application for subsidence monitoring due to gas extraction in the Netherlands, the reader is referred to Chap. 6, preceded by Chap. 5, which addresses the reliability assessment methodology for PSI deformation estimates. Readers who are most interested in the operational use of PSI for monitoring subsidence due to hydrocarbon production are referred to Chap. 7. To conclude, Chap. 8 addresses the potential of PSI for improving knowledge on reservoir behavior.

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