Data Assimilation of SAR-Based Measurements for Geomechanical Characterization (DAG)

Project description

Over the last decade extensive research has been performed at the former Department of Mathematical Models and Methods for Scientific Applications (DMMMSA) of the University of Padova, Italy, to develop computational models to predict both land subsidence due to the development of deep gas fields and land heave/settlement due to seasonal gas storage into depleted reservoirs. The reliability of numerical models is often limited by the uncertainty of the hydrogeological and poro-mechanical input parameters that are required to simulate the actual impact of past and/or future gas-field development scenarios. Extensive research has been recently carried out on data assimilation procedures in hydrogeological modeling. By using available field measurements of the physical processes of interest, data assimilation algorithms allow for: (i) improving the characterization of the soil hydro-geo-mechanical properties, and (ii) reducing the uncertainty in model predictions.

The present DAG project is intended to develop a state-of-the-art data assimilation framework to incorporate measured displacements of the land surface from Synthetic Aperture Radar (SAR)-based technique into the response of Finite Element geomechanical simulation models. By using field observations and numerical models, data assimilation techniques have the potential to significantly reduce the uncertainty associated with ongoing modeling predictions.

Tasks

The project consists of the three major tasks.

Task 1: Ensemble Smoother (ES) Framework Development. In the first phase a combined data-assimilation/simulation framework will be implemented, including a geostatistical analysis of the datasets currently available (prior information) for model parameters, which will be used to generate input ensembles for providing stochastic geomechanical simulations.

Task 2: Tool Validation and Testing. The effectiveness of the devised data-assimilation tool for identifying geomechanical parameter distributions and constitutive relationships will be benchmarked and validated against a series of ad-hoc synthetic examples. Collection of SAR-based measurements will be simulated from reference surface displacement fields generated using the geomechanical code with "deterministically known" geomechanical parameters.

Task 3: Application to test sites in the Upper Adriatic basin, Italy. A demonstrative application of the algorithm will be made on test sites of the Upper Adriatic basin where SAR-based datasets of vertical and horizontal displacements collected between 2003 and 2009 are available.

Partners

The research project is funded by the Italian national oil company ENI E&P and will be carried out at the Dept. of Civil, Environmental and Architectural Engineering (ICEA) of the University of Padova, Italy, under the supervision of Prof. Giuseppe Gambolati. The work is performed in cooperation with the research group headed by Dr. Domenico Baù at the Civil and Environmental Engineering Department at Colorado State University in Fort Collins (CO).

PhD candidate profile

A PhD position is available at the Dept. ICEA of the University of Padova within the DAG research project. Potential candidates are required to have the following qualifications:

- good numerical programming skills (preferred language: Fortran90)
- a solid background in geomechanics and porous media
- good knowledge of the Finite Element method
- knowledge of basic statistics
- good knowledge of English.

More information available at http://www.image.unipd.it/scuola_dottorato/
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