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Surface subsidence prediction for sustainable resource management: robust tools under uncertainty

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Surface ground movements, commonly caused by the generation of underground voids during and after the extraction of mineral and energy resources, can have major impacts to infrastructure at the surface above the extracted panels. Examples, of such impacts may include damage to structures, utilities and buildings, agricultural land as well as to water resources (e.g. due to water abstraction and geomorphic changes of surface water bodies, Karmis et al. 2012). Due to its importance, particularly for longwall mines extracting coal, this challenge has been investigated over several decades, resulting in a number of empirical equations (e.g. Karmis et al. 1990a; Holla and Barkley 2000) and predictive tools utilizing influence functions (Karmis et al. 1990b), while more recently the use of numerical finite difference and finite element methods using sophisticated software is also an option. Even though the use of advanced numerical methods and tools that are capable of simulating the geo-mechanical deformation of the overburden has a significant potential, there are many times where the uncertainties due to lack of detailed information of the structure and properties of soil as well as computational resources required in assessing a plethora of extraction scenarios, may render them a less attractive option.
This study focuses on demonstrating the utility and advantages of applications of some of the above tools, namely: a) empirical equations, b) Surface Deformation Prediction System (SDPS), and c) a meta-analysis derived tool (own research). The meta-analysis tool has been compiled considering functional forms relevant to empirically derived subsidence prediction tools for conventional long-wall coal mining, statistically fit to selected regional data sets available from the literature (including the UK, USA and Australia). Compared to the above methods, SDPS is further capable of doing predictions for more complex panel geometries, and is widely used by researchers, industry and regulatory entities around the world.
The performance of these methods is demonstrated using site-specific information and/or field data from the literature. It is shown that the greatest advantage of these computationally lighter tools is their accessibility and their ability to perform robustly when investigating areas with relatively limited or scarce information, which is helpful for the implementation of appropriate subsidence engineering, supporting preliminary assessments for mine planning and decision-making for damage mitigation measures.

References

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