Groundwater-Climate Relationships, Ranger Uranium Mine, Australia: 3 – Predicting Climate Change Impacts.

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The relationship between groundwater and climate is critical to understand in the design of uranium mine rehabilitation, especially in tropical regions with intense monsoonal rains and extended dry seasons. The Ranger uranium mine is located in the tropics of northern Australia and is surrounded by the world heritage-listed Kakadu National Park – making it imperative to understand the groundwater-climate relationship to ensure that an appropriate rehabilitation design is implemented upon mine closure. This paper is part of ongoing research in applying various techniques to quantify and model groundwater-climate relationships, and is presented for this conference in three closely related papers. In the previous two papers, time series statistical techniques and unsaturated flow models were applied to historic monitoring data over the past 25 years. This paper presents the results of using the unsaturated flow model to predict the long-term impacts of climate change and climate variability on groundwater resources, based on the results of 100-year global climate models (GCMs) and various emission scenarios presented through the Intergovernmental Panel on Climate Change. The critical hydrologic and climate data, namely rainfall and point potential evapotranspiration (PPET), were extracted from 5 GCMs and 7 emission scenarios using the CSIRO's 'OzClim' data tool. All PPET values were converted to actual areal evapotranspiration (AAET) in order to calculate the hydrologic net flux used as the primary input for unsaturated flow modelling. In addition to GCM model output data, the available historical climate data was analysed by the Stochastic Climate Library (SCL) software to obtain a statistical description of climate variability to facilitate a Monte Carlo approach to model a large number of replicates. Finally, given the 100-year timeframe under assessment, potential interdecadal factors in climate variability are also considered, such as the El Nino Southern Oscillation, Pacific Decadal Oscillation and Indian Ocean Dipole, and incorporated into stochastic replicates. As such, based on the 5 GCMs, 7 emission scenarios and inclusion of climate variability using stochastic replicates, more than a thousand model runs were completed to assess the long-term impacts of both climate change and climate variability. The results are then presented with respect to the impacts on groundwater levels over this 100-year timeframe. Overall, the results show the critical importance of climate variability as well as climate change. Under extended wet periods, groundwater levels are predicted to rise significantly, while the major declines are expected under lengthy dry climatic periods. The modelling shows that although the impact of climate change could be significant, it must also be considered in the face of climate variability. The paper, combined with the two concurrent papers, therefore provides a sound methodology and basis upon which to understand the potential impacts of climate change and variability on different uranium mine rehabilitation approaches in a wet-dry tropical climate surrounded by a region of very high conservation and cultural values.

Conference Topics : groundwater; climate change; modelling