Temporal and spatial prediction of lignite mining waste rock pile stability by using artificial neural networks

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Terrain deformation due to soil liquefaction in lignite mining waste rock piles of the northern Lausitz area (Schlabendorf and Seese), have been modeled as time series for the years 2009 – 2013 by using artificial neural networks.

The model has clearly recognized the influences of various lithological and non-lithological controlled parameters on the occurrence of geotechnical events, and these have been quantified and weighted in terms of their importance. The model is able to predict the temporal evolution and the exact spatial location of the event occurring in the dumps as a function of changing groundwater levels and surface morphology.

The predictive success of the model was demonstrated through forecasting of events for the years 2014 and 2015 and their comparison with the observed events of those years.

The following risk factors were identified:

1. Important destabilizing factors are:
    a. a monotonous lithology with the following composition: 96% sand, 3% silt, <1% gravel, lime, clay, coal
    b. kf-values between 10^{-4} and $10^{-4.5}$ m/s
    c. a surface to groundwater distance of 3.45 meters
    d. high gradients of non-lithological controlled parameters: waste dump surface, groundwater level, depth to groundwater and thickness of saturated dump.
2. Important stabilizing factors are:
    a. a high heterogeneity of lithology
    b. a low proportion of sand
    c. high proportions of gravel, silt, clay, lime, or coal
    d. a high depth to groundwater
    e. low gradients of non-lithological controlled parameters: open pit surface, groundwater surface, depth to groundwater, thickness of saturated dump
    f. strongly changing kf values between 10^{-7} and 10^{-2} m/s.

The model can be used as a dynamic tool for risk management before and during the rehabilitation of lignite waste dumps, and for constructing stable waste dumps. By means of varying the model parameters the geotechnical effects of dump design and remediation scenarios can be predicted.