Optimal maintenance decisions for dikes

L.J.P. Speijker[1], J.M. Van Noortwijk[2], M. Kok[3], R.M. Cooke[4].

[1] National Aerospace Laboratory NLR Department of Mathematical Models and Methods, Amsterdam, The Netherlands.
[2] Delft University of Technology Faculty of Mathematics and Computer Science, Delft, The Netherlands.
[3] HKV CONSULTANTS, Lelystad, The Netherlands.
[4] Delft University of Technology Faculty of Mathematics and Computer Science, Delft, The Netherlands.

Abstract

To protect the Dutch polders against flooding, more than 2500 km of dikes have been constructed. Due to settlement, subsoil consolidation, and relative sea-level rise, these dikes slowly sink "away into the sea" and should therefore be heightened regularly (at present, every 50 years). In this respect, one is interested in safe and cost-optimal dike heightenings for which the sum of the initial cost of investment and the future (discounted) cost of maintenance is minimal.
For optimization purposes, a maintenance model has been developed for dikes subject to uncertain crest-level decline. On the basis of engineering knowledge, crest-level decline has been modeled as a monotone stochastic process with expected decline being either linear or nonlinear (i.e., linear after transformation) in time. For both models and for a particular unit time, the increments are distributed according to mixtures of exponentials. In a case study, the maintenance decision model has been applied to the problem of heightening the Dutch "Oostmolendijk."