

Session

Operations Research, Informatics and Beyond

Session:	Operations Research, Informatics and Beyond I
Room:	CB-5
14:15 – 14:45	Ruud Teunter
14:45 – 15:15	Robin Nicolai
Session:	Operations Research, Informatics and Beyond II
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15:45 – 16:15	Edwin Romeijn
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Session: Operations Research, Informatics and Beyond I
Time: 14:45 – 15:15
Room: CB-5
Speaker: Dr. Robin Nicolai (HKV Consultants)
Title: A Necessary Condition for Flood Safety in the Netherlands

It is often claimed that The Netherlands is the safest Delta in the world. Protection against flooding is a vital issue since at least 55% of the country is vulnerable to flooding. Each year the Dutch government spends roughly 1 billion Euros on protection by dikes and dunes. In total there are 3,500 kilometers of primary flood defences in the Netherlands. The statutory flood protection standards for these primary flood defences date back to the early 50's. After the 1953 flood (in Dutch: Watersnoodramp) the first Delta committee asked mathematician David van Dantzig to determine economically optimal dike heights. His research was published in *Econometrica* in 1960 and his recommendations formed the basis for the current safety standards.

Almost 60 years later the population in The Netherlands has grown to 17 million people and the economic value of the low-lying areas behind dikes (Dutch: polders) has increased substantially. Moreover, sea-level rise and sinking land adversely affect the country's flood risk. A national flood risk assessment showed that it was time to reconsider the protection levels. Recently, the Delta program introduced new safety standards for the primary flood defence system using a risk-based approach. The approach takes into account both the probability of flooding and the consequences related to flooding. The consequences are expressed in terms of casualties and economic losses. With respect to economic losses a large-scale cost-benefit analysis and optimization has been performed. In 2013 the 'Dutch Delta team' that solved the problem "Given cost constraints, how can the Netherlands best improve flood protection while minimizing the total long-term expected costs?" earned the Franz Edelman Award in operations research and management science.

It is clear that Operations Research techniques play a prominent role in optimizing flood protection in The Netherlands. Robin shall give a short overview of studies and their results on this topic in recent years, including the most challenging OR-issues. Robin shall also demonstrate the use of OR in other flood risk management problems. For example, flood risk assessments require the tail distribution of sea-water levels, storm surges, discharges and precipitation levels, which can be found by applying extreme value theory. Historical records on these natural phenomena are mostly limited to 100-150 years, yielding large statistical uncertainties in water levels with return periods higher than a thousand years. Since we have not measured such low-frequency water levels in The Netherlands, the physical modelling of water levels inhibits large uncertainties as well. The question is how to avoid the accumulation of such uncertainties in e.g. estimating flood damage and long-term decision-making on flood protection measures.

Another research topic Robin shall address is the cost-optimal maintenance and replacement of hydraulic structures in the waterways and bodies of water in The Netherlands. The last decades the use of the comprehensive and aging infrastructure has intensified. Decision-making on maintenance requires lifetime estimates of structures and information on maintenance/replacement costs in course of time. Robin has developed and applied Bayesian methods to lifetime data of large hydraulic structures and concrete bridges. The resulting lifetime distributions were used to calculate long-term budget requirements for the replacement of these structures.

Many (future) OR challenges remain in the field of flood risk management. One can think of cost-effective strategies for replacing storm surge barriers given sea-level rise and economic developments, the role of uncertainties in (operational) flood risk management, data management, drought and water distribution issues, and dredging optimization.

About Robin Nicolai

Robin Nicolai (1979) studied Econometrics at Erasmus University Rotterdam (EUR). In 2002 he obtained his MSc degree with a thesis on the optimization of a simulation model for breast-cancer screening. In 2008 he obtained his PhD degree from EUR with a thesis on maintenance optimization. Since 2008 he works at HKV Consultants (Lelystad), a company that provides advisory services, high quality research and software products in the field of water and safety. In his role as advisor, researcher and project leader he applies his knowledge of mathematical modelling and statistics in flood risk assessments, uncertainty analyses of hydraulic loads on flood defences and maintenance management of hydraulic structures in The Netherlands.