

# Risk-Based Decision-Making for Evacuation in Case of Imminent Threat of Flooding

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## Abstract

It is important for decision-makers in emergency response situations to determine the scope, scale, timing, path and resettlement area of an evacuation decision when there is an imminent threat of flooding. In this paper, a method called the "Evacuation Diagram" is described to support risk-based evacuation planning and decision-making. In case of an imminent threat of flooding, we refer to the conditional risk, which is the risk given the forecasted water levels and potential consequences during the next days of the event. Given the threat and potential costs and benefits, evacuation decisions have to mitigate this conditional risk. Since evacuation can be costly, decision-makers have to make a trade-off between costs and benefits. In this research we present a method using a cost-benefit analysis approach, in which we adopt the "Dutch flood risk approach" to define the required strength of levees based on flood risk considerations. The "Evacuation Diagram" method is derived from analytical derivations, based on differential weighing of costs and benefits, which have an impact on a binary choice (or a set of discrete choices) as to whether to instruct an area to evacuate or not. Basically, this is an analysis of behavioural decision-making under risk, investigating how a cost-benefit analysis can yield higher cost effectiveness in risk reduction for human lives lost during possible evacuation incidents. The method is applied to a Dutch case study and the results are compared to the outcomes of the largest evacuation exercise ever held in the Netherlands, called 'Waterproef'. It is concluded that the risk-based evacuation method, as presented in this paper, provides useful insight into collective and authoritative evacuation order decisions.

**Keywords:** flood risk; evacuation; probabilistic analysis; cost-benefit-analysis

*The full article can be requested at the publisher or at the Author Professor P.H.A.J.M. van Gelder (p.h.a.j.m.vangelder@tudelft.nl).*