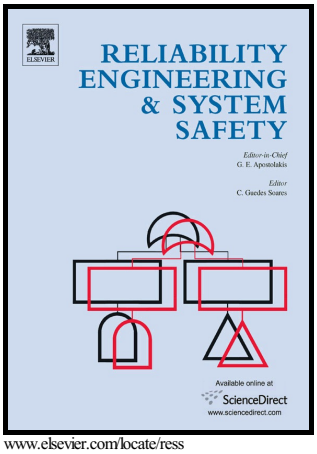

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Multi-objective evacuation routing optimization for toxic cloud releases

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Abstract:

This paper develops a model for assessing the risks associated with the evacuation process in response to potential chemical accidents, based on which a multi-objective evacuation routing model for toxic cloud releases is proposed taking into account that the travel speed on each arc will be affected by disaster extension. The objectives of the evacuation routing model are to minimize travel time and individual evacuation risk along a path respectively. Two heuristic algorithms are proposed to solve the multi-objective evacuation routing model. Simulation results show the effectiveness and feasibility of the model and algorithms presented in this paper. And, the methodology with appropriate modification is suitable for supporting decisions in assessing emergency route selection in other cases (fires, nuclear accidents).

Keywords: Risk analysis, Major chemical accidents, Evacuation planning, Multi-objective optimization, Routing

Nomenclature

$G(V,E)$	regional evacuation network
V	set of nodes, $V=\{v_1,v_2,\ldots v_n\}$
E	set of arcs, $E\subseteq V\times V$
v_1	origin node
v_n	destination node
n	number of the nodes
l_{ij}	length of the arcs nodes v_i and v_j, where $(v_i , v_j) \in E$
u_{0ij}	travel speed on arc (v_i, v_j) under normal conditions
$u_{ij}(t)$	travel speed on arc (v_i, v_j) in the affected area at time t under conditions of toxic gas leak.
α_{ij}, β_{ij}	decrease parameters
t_{ij}	time needed to travel through arc (v_i , v_j)
t_i	time when people reach node v_i,
R	feasible egress route between the origin node and destination node
P_f	probability of failure
f	occurrence probability of the chemical accident
$P_{d\|f}$	probability of dying of an individual in the case of failure
X	"probit" variable
a, b,χ	constants depending on the types of chemicals;
D	lethal dose, for toxic materials