Pre-disaster Self-evacuation Transport Network Design under Uncertain Demand and Connectivity Reliability: A Novel Bi-level Programming Model

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This research proposes a novel bi-level nonlinear programming model for the pre-disaster self- evacuation transport network design. The model takes into account both uncertainties of demand and connectivity reliability, an approach to quantify network connectivity reliability is proposed based on percolation theory, and an upper-level model is developed with the minimum evacuation time and maximum connectivity reliability, while the lower-level is a traffic assignment model that describes people's evacuation route choice behaviour, with the objective of total utility maximization, and the regret-risk utility function is proposed as the lower-level model objective function, and an equilibrium condition to improve the Logit model based on the regret-risk utility function is also proposed. For the uncertain demand in the bi-level programming model, the Robust Optimization (RO) approach is used for its solvable transformation, and an Improved Genetic Algorithm combined with Non-dominated Sorting Genetic Algorithm II(IGA-NSGA-II) is designed to solve this model. The Nguyen-Dupuis network is used as a test network to demonstrate that the approach developed in this paper can be used to solve a multi-objective bi-level nonlinear programming model and to obtain a satisfactory design solution for self-evacuating transportation networks. Not only that, the risk aversion parameter and regret aversion parameter in the regret-risk utility function can be observed to have significant effects on the model solution through parameter sensitivity analysis. The Central Coast region of New South Wales, Australia is used as a case study, and the research output will help government authorities to plan and design a pre-disaster self- evacuation transport network.