

REILP Approach for Uncertainty-Based Decision Making in Civil Engineering

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Abstract: The civil and environmental decision-making processes are plagued with uncertain, vague, and incomplete information. Interval linear programming (ILP) is a widely applied mathematical programming method in assisting civil and environmental decision making under uncertainty. However, the existing ILP decision approach is found to be ineffective in generating operational schemes for practical decision support due to a lack of linkage between decision risk and system return. In addition, the interpretation of the ILP solutions represented as the lower and upper bounds of decision variables can cause problems of infeasibility and nonoptimality in the resulted implementation schemes. This study proposed a risk explicit ILP (REILP) approach to overcome the limitations of existing ILP approaches. The REILP explicitly reflects the tradeoffs between risk and system return for a decision-making problem under an interval-type uncertainty environment. A risk function was defined to enable finding solutions which maximize system return while minimizing system risk, hence leading to crisp solutions that are feasible and optimal for practical decision making. A numerical experiment on land-use decision making under total maximum daily load was conducted to illustrate the REILP approach. The model results show that the REILP approach is able to efficiently explore the interval uncertainty space and generate an optimal decision front that directly reflects the tradeoff between decision risks and system return, allowing decision makers to make effective decision based on the risk-reward information generated by the REILP modeling analysis.

DOI: 10.1061/(ASCE)CP.1943-5487.0000037

CE Database subject headings: Computer programming; Risk management; Decision making; Environmental engineering.

Author keywords: Interval linear programming (ILP); Risk explicit ILP (REILP); Decision making; Risk function; Aspiration level; Normalized risk level (NRL); Civil engineering.