Risk management for forestry planning

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The forest-harvesting and road-construction planning problem basically consists of managing land designated for timber production and divided into harvest cells. For each time period in the given time horizon one must decide which cells to cut and what access roads to build in order to maximize expected net profit under a risk manageable scheme to control the negative impact of the solutions in the profit of low-probability high-loss scenarios (i.e., the so-called black swans). A tighter formulation of the deterministic mixed 0-1 model introduced in [2] is presented as well as its stochastic counterpart (that itself is a detailed extension of the simplified risk neutral version that we have presented in [1]. The high variability of the uncertain parameters, say, timber price and demand along the the time horizon (in our case, three years, partitioned in six periods) makes misleading to replace the realization of the scenarios with the related expected value (EV). The stochastic version of the problem enables the planner to make more robust decisions than the (deterministic) EV version. The tighter multistage stochastic model is based on considering a set of representative scenarios along thetime horizon. The following versions of risk management are considered: RN (Risk Neutral), where the expected profit maximization does not hedge against the impact of the solution in the black swan scenarios, TCVaR (Time-inconsistent Conditional Value-at-Risk) risk-averse measure, where a modeler-driven subset of intermediate periods is considered in the time horizon for profit risk reduction, ECVaR (time-consistent, Expected Conditional Value-at-Risk, where the profit risk reduction is performed on the total profit in the time horizon for a modeler-driven subset of scenario groups, and MCVaR, a risk averse measure that is a mixture of the other two. We follow the definition of time-consistency property given in the literature, see [3] and others. The advantages of controlling high-loss periods and drawbacks of that control are analyzed, by performing a broad computational experience on a large-sized realistic forest harvesting planning problem, where the strategies EV, RN, TCVaR, ECVaR and MCVaR are computationally compared.

References

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