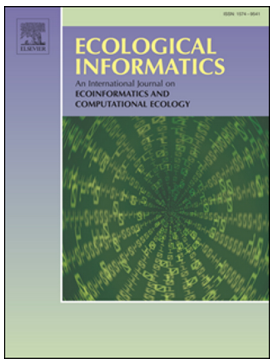

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Fuzzy modelling of growth potential in forest development simulation

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Abstract

In the paper, we introduce a new fuzzy-based model for calculation of plant growth potential in the context of forest development simulation, which is an important tool for prediction and monitoring of forest biodiversity. When modelling a forest ecosystem, one needs to account for a significant amount of ambiguity in the specification of plant requirements and environmental conditions, whose overlap determines the competitive potential of co-occurring species. The proposed fuzzy model addresses the imprecision and uncertainty about proper interpretation of numerically estimated growth conditions with respect to linguistically specified plant requirements. Individual requirement levels are represented as fuzzy sets to which estimated growth conditions are mapped, while plant needs are modelled as fuzzy numbers with adjustable tolerance radii. The growth potential with respect to a particular resource is then calculated as a membership of condition mean in a fuzzy set of plant demand. We validate the model operation within the ForestMAS simulator on real data obtained from six decades of observations registered at a forest fire recovery site in northern Slovenia. We show that the enhanced expressiveness about the tolerance of tree species to deviations of growth conditions allows the fuzzy model to improve the accuracy of forest composition prediction with respect to the crisp model. Sensitivity analysis also shows that, in many cases, the fuzzy model increases simulation robustness with respect to vaguely defined plant needs and estimated site conditions.

Keywords: Fuzzy modelling, Forest development simulation, Ecological monitoring, Growth potential calculation.

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