Jul 13th, 9:10 AM - 9:30 AM

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International Environmental Modelling and Software Society (iEMSs)
8th International Congress on Environmental Modelling and Software
Toulouse, France, Sabine Sauvage, José-Miguel Sánchez-Pérez, Andrea Rizzoli (Eds.)
http://www.iemss.org/society/index.php/iemss-2016-proceedings

Modelling Forest Insect Outbreaks: Efforts Towards an Inverse Approach to Model Calibration

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Abstract: Modelling and simulation of epidemic insect outbreaks are powerful tools to be used in planning and preparing strategies for forest management under climate change. Calibration is a fundamental part of the modelling strategy. It aims to find those parameter values that allow the best characterization of emergent spatiotemporal dynamics within the system being modelled. In this study we implemented a cellular automata (CA) model to simulate the mountain pine beetle (MPB) epidemic in western Canada, which has killed about 50% of the total volume of commercial lodgepole pine in the province since 1990. We used spatial information on annual mortality of pine trees due to MPB attacks, provided by the Ministry of Forests of British Columbia. The 15 years' series (2000-2014) was used to calibrate the model. We used elevation, aspect and closest infested pixel as predictors. We implemented a binomial linear regression with logit link function to derive statistically the CA rule. Regressions were calculated between pair of images separated by 1, 2, 3 and 4 years. The resulting coefficients were most of the time statistically very significant ($p<<0.01$). We then carried out a preliminary analysis of those regression coefficients as a function of infestation year. Our results show that infestation rates changed noticeably around 2006, which coincides temporally with the peak of MPB infestation in the province. The predictive ability of the models was evaluated via AUC indices, which varied between 0.83 and 0.95 for 1-year predictions and 0.81 and 0.92 for 4-year predictions.

***Keywords**:* Complex systems; cellular automata; model calibration; forest insect disturbance; inverse modelling.