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Sobol' sensitivity analysis for stressor impacts on honeybee colonies

Carmen Kuan

Oak Ridge Institute of Science and Education, kuan.carmen@epa.gov

Robert Curry

Crystal River Consulting, stratpilot@gmail.com

Gloria DeGrandi-Hoffman

USDA Agricultural Research Service

Kris Garber

U.S. EPA, Office of Pesticide Programs

Andrew Kanarek

U.S. EPA, Office of Pesticide Programs

See next page for additional authors

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Presenter/Author Information

Carmen Kuan, Robert Curry, Gloria DeGrandi-Hoffman, Kris Garber, Andrew Kanarek, Marcia Snyder, and Tom Purucker

Sobol' sensitivity analysis for stressor impacts on honeybee colonies

Carmen Kuan¹, Robert Curry², Gloria DeGrandi-Hoffman³, Kris Garber⁴, Andrew Kanarek⁴, Marcia Snyder⁵, Tom Purucker⁶

¹*Oak Ridge Institute of Science and Education, Athens, GA, kuan.carmen@epa.gov;*

²*Crystal River Consulting, Tucson, AZ, stratpilot@gmail.com;*

³*USDA Agricultural Research Service, Tucson, AZ;*

⁴*U.S. EPA, Office of Pesticide Programs, Arlington, VA;*

⁵*U.S. EPA, Office of Research and Development, Corvallis, OR*

⁶*U.S. EPA, Office of Research and Development, Athens, GA*

We employ Monte Carlo simulation and non-linear sensitivity analysis techniques to describe the dynamics of a bee exposure model, VarroaPop. Daily simulations are performed of hive population trajectories, taking into account queen strength, foraging success, mite impacts, weather, colony resources, population structure, and other important variables. This allows us to test the effects of defined pesticide exposure scenarios versus controlled simulations that lack pesticide exposure. The daily resolution of the model also allows us to conditionally identify sensitivity metrics. We use the variance-based global decomposition sensitivity analysis method, Sobol', to assess first- and second-order parameter sensitivities within VarroaPop, allowing us to determine how variance in the output is attributed to each of the input variables across different exposure scenarios. Simulations with VarroaPop indicate queen strength, forager life span and pesticide toxicity parameters are consistent, critical inputs for colony dynamics. Further analysis also reveals that the relative importance of these parameters fluctuates throughout the simulation period according to the status of other inputs. Our preliminary results show that model variability is conditional and can be attributed to different parameters depending on different timescales. By using sensitivity analysis to assess model output and variability, calibrations of simulation models can be better informed to yield more accurate predictions of complex ecological processes.

Keywords: pollinator, sensitivity analysis, colony population model, pesticides