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Development of structure sensitivity analysis methods

Most of the time, sensitivity analyses performed on mathematical models are limited to those concerning the parameters. Though, it has been shown that the mathematical formulation of the biological processes that one wants to model can also be very important for the dynamics of ecological systems. For instance, several authors have highlighted that the choice of the functional response formulation, which gives the consumption rate of predators as a function of prey density, can have a strong impact on predator-prey models behavior and stability. This is referred by [1] as a new type of model sensitivity, called the structure sensitivity of the model.

The formulation of biological processes can be very complex and it is not rare to find several possible mathematical expressions to model one process. Indeed, the process studied is often difficult to measure in the natural medium and it is approximated by functions estimated from laboratory or *in situ* experiments. These functions are considered as a good approximation of the phenomenon observed in natural systems, which is of course questionable since it has been demonstrated that natural systems are much more heterogeneous than simplified laboratory systems.

In this context, we have decided to develop some simple mathematical methods that will help modelers to detect and to measure if their system is sensitive to the formulation of the process studied. We argue that this type of analysis is essential if one wants to be able to use and comment informations obtained from model simulations. We show an example of application by investigating the effects of the functional response formulation on a chemostat-type predator-prey model dynamics. We find that the system does exhibit structure sensitivity, which is even stronger than system parameters sensitivity.

References

[1] Wood, S. N. and Thomas, M. B., 1999. Super-sensitivity to structure in biological models. *Proc. R. Soc. Lond. B* **266,** 565-570.