

STOCHASTIC NUMERICAL MODELLING FOR SUSTAINABILITY

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Abstract

In this talk, we investigate the role of stochastic numerical modelling in sustainability-oriented dynamical systems, with the aim of describing the interplay among production processes, environmental constraints, and uncertainty. Environmental variability is incorporated through a stochastic carrying capacity governed by an Ornstein-Uhlenbeck process. This results in a coupled model in which production, resource availability, and economic performance evolve under the influence of random environmental fluctuations.

The proposed approach highlights the importance of structure-preserving solvers for reliable long-time simulations of sustainability-related systems and provides a basis for the numerical investigation of environmentally constrained models under uncertainty. For stochastic θ -Maruyama discretizations, we derive conditions ensuring the preservation of the mean-reverting behaviour of the continuous problem and analyse the asymptotic second moment of the numerical solution. The theoretical analysis clarifies the influence of the method parameter and stepsize on environmental stability and long-time properties under discretizations. Numerical experiments complement the theoretical results and illustrate the effects of the discretization parameters on the computed trajectories.

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Keywords: stochastic differential equations; stochastic θ -methods; sustainability modelling; long-time behaviour.

References

- [1] R. D'Ambrosio, Stochastic numerics for sustainability, submitted.
- [2] R. D'Ambrosio, Numerical Approximation of Ordinary Differential Problems: From Deterministic to Stochastic Numerical Methods, Springer, Cham, 2023.
- [3] D. J. Higham, Mean-square and asymptotic stability of numerical methods for stochastic ordinary differential equations, SIAM J. Numer. Anal., 38(3), 753–769, 2000.