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GRADUAL CHANGES AND SUDDEN SHIFTS IN ECOSYSTEMS WITH HUMAN INTERACTIONS: A NONLINEAR DYNAMICAL APPROACH

Lucia Russo[1]*, Konstantinos Spiliotis[2],
Francesco Giannino[2], Constantinos Siettos[3]

[1] Istituto di Ricerche sulla Combustione,
Consiglio Nazionale delle Ricerche, Napoli, Italy

[2]Dipartimento di Scienze Agrarie,
Universita' degli Studi di Napoli Federico II, Napoli, Italy

[3]National Technical University of Athens,
School of Applied Mathematics and Physical Sciences, Athens

lucia.russo@irc.cnr.it (*corresponding author), spiliotiskos@gmail.com,
giannino@unina.it, ksiet@ntua.mail.gr

The interplay of both natural causes and human activities/interventions drives both gradual changes and sudden shifts on entire ecosystems with many times catastrophic consequences. Thus, the systematic modeling, analysis and forecasting of the complex behavior of ecosystems in response to their ongoing changes constitutes one of the major challenges of nowadays. Over the last few years, simple mathematical models in the form of ordinary and/or partial differential equations have been proposed to approximate in a qualitatively manner the observed complex phenomena. While, the vast majority of the studies dictate the importance of the notion of bifurcation for the better understanding of the mechanisms that pertain to regime shifts, most of them use simple temporal simulations to analyse and thus identify criticalities that mark the onset of phase transitions. In this paper, we stress the importance of using the full arsenal of numerical bifurcation theory to systematically identify and characterize criticalities in ecological models in the two dimensional parameter space. Towards this aim we revisit the analysis of a simple model of a forest-grassland mosaic ecosystem. We construct the bifurcation diagrams in the two dimensional (2D) parameter space with respect to the weight of human inuence and natural causes. Based on the 2D bifurca-

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tion analysis we show that simple simulations and even simple 1D bifurcation analysis could be inadequate and even drive to misleading conclusions for the overall system behavior.

References

[1] C. Innes, M. Anand, C.T.Bauch, (2013). Scientific Reports 3, Article number 2689.

[2] Russo L. and Spiliotis C., 2016. *Bifurcation analysis of a forest-grassland ecosystem*, AIP Conf. Proc.,1738, 150005.

[3] Russo, L., Spiliotis, C., Siettos, C., 2016. *Catastrophic transitions in a forest-grassland ecosystem*, Chemical Engineering Transactions 53, pp. 229–234.

[4] Spiliotis C. and Russo L., 2016. *Shifts and oscillations in a forest-grassland ecosystem*, AIP Conf. Proc.,1738, 150005.

[5] Russo, L., Spiliotis, K Giannino, F., Siettos, C.I., Mazzoleni, S., 2017. *Mapping regions with different dynamics in a forest/grassland model in presence of fire*, AIP Conference Proceedings, Volume 1906, 28 November, Article number 100010.

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