NUS National University of Singapore | Department of Biological Sciences, Faculty of Science

BIOLOGY COLLOQUIUM

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Hosted by Dr Ryan Chisholm

Abrupt transitions in ecological systems



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Diverse range of complex systems can reach tipping points where they abruptly switch to a state with contrastic features. Such transitions are also called critical transitions. Commonly cited empirical examples of critical transitions are desertification in semi-arid ecosystems, algal blooms in aquatic ecosystems, paleo-climatic shifts, and crashes in financial markets. More recently, these ideas have also been applied in genetic circuits and regulatory networks. Due to potental impact of such unexpected events, there has been a focus on developing predictors of critical transitions. In this talk, I will present how ideas from bifurcation thoery in mathematics and non equilibrium phase transitions from physics can be employed to devise early warning signals of critical transitions. The most prominent of among these early warning signals are 'critical slowing down', rising variance and changing skewness in the state of the system. I will discuss empirical evidence for these theoretical predictions. I will then focus on our recent work on analyzing real data of Savanna ecosystems (e.g., woodland to grassland transitions) and financial market crashes. Our analysis suggests abrupt transitions in these systems are not critical transitions. Rather, I argue for that these are stochastic transitions where the because of strong perturbations, systems exhibit abrupt transitions even when the system is far from tipping points.

Artwork by Ann Nee, DBS, NUS