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Stochastic resonance in riparian and wetland ecosystems

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Riparian and wetland ecosystems are known for their environmental and ecological value. Understanding the response of these ecosystems to anthropogenic disturbances and natural fluctuations is of foremost importance to the management and restoration of these ecosystems. The presence of noise forcing the dynamics of a deterministic non-linear system can lead to different and, sometimes, unexpected behaviors. Usually, noise is associated with disorder. However, a number of studies have proposed examples demonstrating that noise can also play a "constructive" role in the dynamics of non-linear systems, in that random fluctuations can induce new dynamical behaviors that do not exist in the deterministic counterpart. Especially interesting is the phenomenon of stochastic resonance. In the case of stochastic resonance, a periodic deterministic external driver and a stochastic driver cooperate to induce regular transitions between different states of a dynamical system. The fundamental ingredients of the phenomenon of stochastic resonance are three: i) a bistable or an excitable dynamical system; ii) an external random forcing; and iii) a (weak) deterministic periodic forcing. The key point is that a threshold crossing is activated by a random forcing and the consequent transitions between states has a typical scale. A suitable synchronization with a weak periodic forcing can activate a sort of resonance. In ecohydrology, some wetlands were actually described as bistable or excitable systems but, despite the pervasive presence of random and periodical fluctuations in environmental processes, applications of the theories of stochastic resonance to describe wetlands dynamics are still lacking. In this work we show that when some wetland ecosystems are subjected to periodic and random forcing, they can give rise to time-ordered dynamics, indicating the possible emergence of stochastic resonance.