Sensitivity analysis for time varying ecological networks

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We generalize the sensitivity analysis to press perturbations for ecological networks described by time varying (non autonomous) ODE systems. Despite that, in a time-invariant (autonomous) framework, the sensitivity analysis has been successfully employed to assess the overall effects stemming from sustained changes in species growth rates on the equilibrium values of other indirectly related species. In particular, it has been proved that the senstitivity matrix -S is the inverse of the community matrix A associated to the network.Nevertheless, the generalization to the time varying case has remained elusive and our generalization is based in two classical topics of ordinary differential equations:The smoothness of solutions with respect to parameters.The properties of exponential dichotomy and admissibility.The above topics combined with recent advances in the theory of non autonomous dynamical systems inspired on the new concept of non autonomous equilibrium and its local properties enable us to derive the sensitivity matrix as the solution of a non homogeneous linear matrix differential equation, which can be explicitly computed by using results from exponential dichotomy and admissibility. We provide additional details for the periodic and almost periodic case.In addition, time averaging provides alternative characterizations for the sensitivity matrix in terms of the community one. This is made by revisiting the notion of expected value developed R. Levins. Finally, we provide a detailed example arising from a periodic Lotka-Volterra system combined with numerical simulations

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