Modeling population dynamics and control strategies for a unique species evolving in heterogenous landscape

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MODELING POPULATION DYNAMICS AND CONTROL STRATEGIES FOR A UNIQUE SPECIES EVOLVING IN HETEROGENOUS LANDSCAPE

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We study a single-species metapopulation model with patches connected by linear diffusion. Inspired by the framework inaugurated by Takeuchi in [7] and Takeuchi and Lu in [4], and using tools of cooperative system theory [6], we show that under appropriate conditions, the sign of the stability modulus of the Jacobian of the system at the origin determines the asymptotic behaviour of the solutions. If it is non-positive, then the population becomes extinct in every patch. Conversely, if it is positive, then there exists a unique nonnegative equilibrium, which is positive and globally asymptotically stable.

In the latter case, given a subset of 'controlled' patches where human intervention is allowed, we study whether introducing additional mortality terms in these patches can result in population elimination in every patch. We characterize this possibility by an algebraic property on the graph of the residual, uncontrolled, system. When the population persists whatever the control, we assess the minimal attainable positive equilibrium value. When extinction is possible, we study the optimization problem consisting in achieving this task while minimizing a certain cost function, chosen as a nondecreasing and convex function of the mortalities added in the controlled patches. Using the (strict) convexity properties of the spectral radius of a non-negative matrix with respect to its diagonal elements [1, 3, 5], we show that such minimization problem admits a global minimizer, which is unique when not every patch is controlled.

This presentation stands within the framework of an ongoing project, AttracTIS, in Réunion island, which aims at studying a combination of vector control tools against *Bactrocera dorsalis*, including the Sterile Insect Technique [2]. This pest, also called oriental fruit fly [8], invaded Réunion island in 2017 and since then has been impacting significantly the production of fruits, in particular mangos.

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