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Multi-objective design of sustainable agroecosystems to regenerate deforested lands

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Multi-objective design of sustainable agroecosystems to regenerate deforested lands

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Abstract: Agriculture is a major cause of deforestation and of the consequent GHG emissions, biodiversity and ecosystem degradation. Nevertheless, agriculture represents an attractive solution to both recover the lost forest ecosystems and fight deforestation, by supporting the provisioning of food and other ecosystem services. These benefits strongly rely on the type of agroecosystem management practices adopted by the farmer, among which crop selection plays a key role. Traditionally, farmers aim at maximizing their yield and income, but those objectives should be integrated with social and environmental ones. This is particularly evident in areas like the Amazon, where the ecosystem conservation lies in the forefront and represent a source of alternative income (e.g., Payment for Ecosystem Services). Given this context, the present work aims at assessing the contribution of agriculture in tackling deforestation and the loss of forest diversity. This is achieved by formulating an optimization problem for the selection of a plant species for a given agricultural area, taking into account their evolution over the years. We define: (i) a set of objectives covering the dimensions of sustainability (maximization of income, income stability, biodiversity, and carbon storage), and (ii) a system of constraints to guarantee the coexistence between species and their productivity. We run the solver to identify the best solutions that either optimize the single objective problems or evaluate their the trade-offs: a clear conflict between short term economic objective and environmental ones has emerged, but it can be compensated by the ecological performance of the most forest-like agroecosystems.

Keywords: complex agroecosystems; sustainable agriculture; multi-objective optimization; deforestation.