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Effects of the resources transfer between communities under a policy of responsibility in the framework of sustainability

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Abstract: Transfer resources from a community with abundant resources to one with high consumption but with a clear and strict policy of responsibility in terms of exploitation has been modelled to understand if the dynamics can lead to sustainable development. A system will be said to be sustainable if well-being is a non-negative conservation law. A Filippov system is used to model the interaction between the communities, considering exploitation limits across two switching regions from the high-consumption community, so that the policy from only one of the communities leads to the protection of the resources in both communities. Interpreting well-being as resource tenure in the presence of the population, invariant sets were identified that demonstrate that this policy of responsibility can lead to sustainable development. Finally, if the resilience of the socioecological system is studied through a non-smooth bifurcation analysis, break a sustainability condition does not necessarily mean losing the sustainability.

Keywords: renewable resources transfer, sustainability, Filippov system, non-smooth bifurcations

1. Introduction

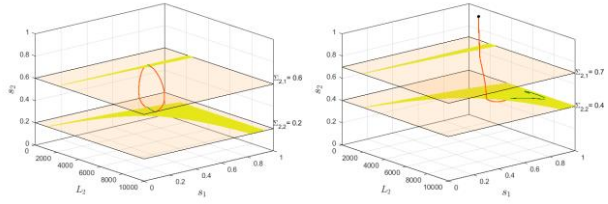
The creation of wealth through the division of labour led the territories to specialized production that triggered the need for exchange, giving rise to the supply of the products obtained and the demand for those that the territory lacked. Within the framework of sustainable development, the exchange of resources is of great interest because, for example, a unidirectional exploitation relationship puts the economic situation of the nation supplying raw materials at risk, while the nation that demands them is enriched by granting them added value using science and technology, generating an asymmetry in development that can translate into social instability for the two nations in the relationship. A landscape or territory is said to be sustainable if its definition of well-being is a non-negative conservation law (time symmetry) of the variables that define it [1], which is derived from an interpretation of sustainable development proposed in Our Common Future [2]. In this sense, the emergence of invariant sets in the dynamics of the behaviour of a socio-ecological system such as landscapes and territories show us that sustainability can have different geometries. The purpose of this article is to present the results obtained after modelling the unidirectional exchange between two communities that act under a policy of responsibility, which consists of a clear identification of decision limits regarding the exploitation of their resources through Filippov Systems. The differential system used is a model of the Brander & Taylor type [3], such as the one presented in Equation 1, where there is a conservation policy.

$$
\begin{aligned}
\dot{L_1} &= C_1\phi_1\epsilon_1 L_1S_1 - \sigma_1 L_1 \\
\dot{S_1} &= \rho_1 S_1(S_1/T_1 - 1)(1 - S_1/K_1) - \epsilon_1 L_1 S_1 \\
\dot{L_2} &= \phi_2\epsilon_2 L_2 S_2 + (1 - C_1)\phi_1\epsilon_1 L_1 S_1 - \sigma_2 L_2 \\
\dot{S_2} &= \rho_2 S_2(S_2/T_2 - 1)(1 - S_2/K_2) - \epsilon_2 L_2(S_2 - S_{1\to 2})
\end{aligned}
\tag{1}
$$

where L_i y S_i are the population and the resources stock of the i-th community, ϕ_i, ϵ_i, σ_i, ρ_i, T_i and K_i are system parameters, C_1 is a cooperation parameter from community 1 to community 2 and $S_{1\to 2}$is the amount of protected resource. The decision limits are expressed through switching surfaces in the community that uses the resources of the other. For this work, two were used: the emergency region for the protection of own resources and the responsibility region for the protection of the resources of the contributing community.

2. Results and Discussion

Different paths of sustainable development were found, expressed through invariant sets with sliding, as shown in Figure 1, which indicates that responsible exploitation policies from one of the communities can lead to sustainable dynamics between the communities involved. Also is shown that, if the resilience of the socioecological system is studied through a non-smooth bifurcation analysis, break a sustainability condition does not necessarily mean losing the sustainability, but the system can express another sustainability geometry.



(a) (b)

Fig. 1. Different paths of development involving two switching regions. (a) periodic orbit with double sliding, (b) convergence to a pseudo-equilibrium

3. Concluding Remarks

The effect of transferring resources from a community with abundant resources to one with high consumption but with a clear and strict policy of responsibility concerning exploitation can lead to a sustainable dynamic. The result is added to those obtained to affirm that the role of the consumer is preponderant for the generation of well-being, even over those communities with foreign policies but subject to the exchange policy.

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