The Paradox of Innovation on Systemic Risk: a System Dynamic model

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The study proposes a System Dynamics model of an agricultural-based society isolated from the rest of the world. This society can produce a given amount of calories for each squared km of land. The number of inhabitants increases if there are enough calories to satisfy the need of the population. Otherwise, it decreases. The land usage erodes the terrain and makes it less fertile: the erosion is proportional to the level of the population (hence, the pressure on the resource). Oppositely, the resource has a given rate of recovery. Consequently, only when the population exceeds a certain threshold, the fertility starts to decrease. Besides, fertility is affected by the technological level, which influences the number of calories extractable from every squared km of cultivated terrain. The model was calibrated on the population on Easter Island (imposing the technological level to 1) to provide a more realistic setting for the experiment.

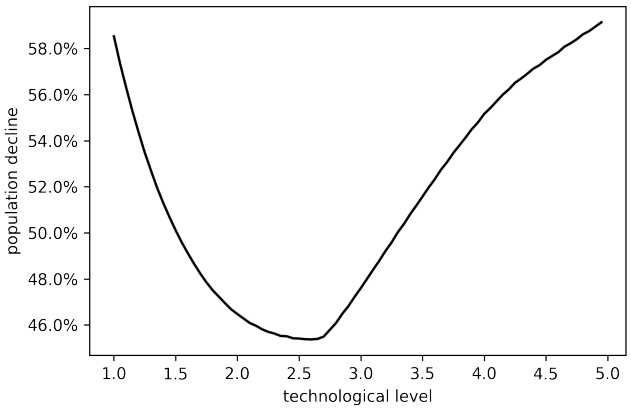

Figure 1: Change of the values of population decline (in %) in the simulation model for different technological levels

The simulation of the model using different technological states shows a non-linear relationship between the technological level and the magnitude of the population decay. Specifically, low increments of the technology state reduce the decline of the population (i.e., the ratio between the final level and the level at its peak). After a threshold, it begins to rise again. The simulation of this simple model shows the following paradox: the systemic risk could be increased by better technological ability in generating food. This work intends to contribute to the understanding of the roots of systemic risks in a socio-ecological system. Further developments include the extension of this model (for example, including technological improvement during the simulation) or the generation of an Agent-based model to address heterogeneity in the territory and individuals behaviour.