Review of: "Gamification of the overexploitation of natural resources. An operational game based on System Dynamics"

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This is an interesting and timely paper that attempts to make a somewhat technical mathematical result (viz., the Hubbert curve that describes the outcome of the exploration of a non-renewable resource as a function of time) more intuitive to lay people through the gamification of the consumer-resource dynamics. In that sense, the paper follows the exhortation that science must have a comprehensible form and that it will only persist as society's epistemic stronghold if scientists manage to redistribute the "treasure of knowledge" (Bardi et al., 2022).

Here I would like to point out an alternative mathematical framework to model the consumer-resource dynamics. The authors follow a long tradition of modeling this dynamics using Lotka-Volterra predator-prey models, where man is seen as the predator and the resource base as the prey. However, this approach to human-nature dynamics misses the point that humans do not primarily prey on nature but modify it: humans are the ultimate ecosystem engineers, who have shaped the world into a more hospitable place for themselves, most often with unlooked-for long term effects (Smith, 2007). One such effect is the collapse of human societies likely caused by habitat destruction and overpopulation (Diamond, 2005). Accordingly, the ecosystem engineers framework (Gurney & Lawton, 1996; Lopes & Fontanari, 2019) offers a more natural paradigm to address human-nature interactions than the predator-prey models. In particular, in that framework the growth of the population is determined by the availability of usable habitats, which in turn are created by the engineers through the modification, and consequent destruction, of virgin habitats. The spatial distribution of habitats (Franco & Fontanari, 2017) could model the dynamic coupling between the population of engineers, the not-yet discovered resource sources (e.g., oil wells), the sources that are currently in use and the degraded sources. Thus, the relentless search and exploration of those resources is akin to the expansion of a population in a virgin territory. The interesting outcome of the study of this scenario is that when the colonization front reaches the boundary of the available space, the population density plunges sharply and attains its equilibrium value. This collapse takes place without warning and happens just after the population reaches its peak number (Fontanari, 2018). Hence it seems that overpopulation and the consequent collapse of an expanding population of ecosystem engineers is a natural consequence of the nonlinear feedback between the population and environment variables. In a sense, this finding dovetails with Hardin's rather gloomy conclusion that the freedom to breed must be curtailed by some form of mutually agreed coercion in order to avoid the tragedy of the commons (Hardin, 1968).

Most interestingly, the gamification process used by the authors to "solve" their deterministic predator-prey equations (1) and (2) is actually very similar to the Gillepie algorithm used to simulate chemical reactions when the number of reagents and products are finite (Gillespie, 1977). In fact, minor changes of the rules of the Moby Dick game discussed in the paper would lead to an analog (or, better, human) implementation of Gillepie's algorithm to simulate the stochastic counterparts of equations (1) and (2).

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