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Comment

# The power of games
# Comment on “Climate change governance, cooperation and self-organization” by Pacheco, Vasconcelos and Santos

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Cooperators are those who contribute to a common pool while Defectors just exploit the formers’ investments. If we follow the most rational individual choice then no one should contribute hence there would be nothing to exploit. This dilemma is at the heart of every conflict which is summarized as the problem of cooperation and provides the natural setting for the occurrence of the tragedy of the commons. It emerges in a wild variety of fields and systems ranging from the smallest, such as viruses and bacteria, to the largest ones which are formed by countries with partly conflicting interests [1]. The present study [2] focuses on the latter end of this spectrum by considering the global warming problem, which importance cannot be exaggerated. Traditionally, Game Theory is supposed to describe the mathematical framework of conflicts. These problems could be especially challenging when we analyze the competition of several participants whose collective behavior elevates the difficulty to a higher level. This complexity, however, provides an attractive hunting field for scientists with a statistical physics background: concepts familiar to them, such as phase transitions, pattern formation, scaling and universal behaviors have allowed this field to flourish in the last two decades. The present work is a beautiful example of this research avenue.

Rather surprisingly, the Evolutionary Game Theory formulation, where peer influence is considered, offers a powerful general approach to the basic problem. In their paper Jorge M. Pacheco and his colleagues propose an elegant model which catches the essence of the conflict we face regarding global warming. As they highlight, there is no alternative way to avoid the problem. If we fail – everybody fails: no matter how we behaved earlier. This is a crucial point which is modeled by using the collective risk concept [3]. Their significant observation is that the risk of collective failure constitutes one of the most important variables which may drive competitors toward higher levels of cooperation. “The larger the overall perception of risk, the easier it is to successfully coordinate for the global good.” At first it sounds like a relaxing message because we may think that our world should cooperate as the risk becomes higher, but their other result dissolves this illusion very quickly. Some uncertainty in the risk threshold can easily destroy the healthy state of society, such that a significantly higher threat is necessary for achieving the same cooperation level. Unfortunately the ambiguity issue, as I will argue later, cannot be excluded.

Luckily they have some constructive suggestions on how to escape the tragedy of the commons. According to their research, higher cooperation levels can be achieved “by segmenting tasks in small to medium sized groups.”

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The recipe is conceptually similar if we apply punishment to maintain the commons: instead of global and centrally governed institutions they argue for local and regional efforts allowing bottom-up organization. This finding may sound provocative for todays' leaders who are trying to solve the basic problem in a centralized way, but not for those who followed the development of Evolutionary Game Theory. As we already learned from the seminal model of Nowak and May [4] and from the equivalently important observation of Santos and Pacheco [5], stable interactions with locally organized groups are those conditions in which reciprocity is augmented, hence giving chance for a higher cooperation level.

As every thought-provoking model which provides us with deep understanding of a basic problem, the present work is just the beginning of related efforts. Already the authors highlight some avenues we should consider in further studies. Evidently the complexity of human interactions and the heterogeneity of participants, for example wealth inequality, are significant conditions we should not overlook. Clearly the study of more realistic, hence more complex situations cannot avoid the application of agent-based computational models and Monte Carlo simulations. Furthermore, conditional cooperation, as a way to consider more complex strategies, could be especially interesting. By making contracts such as 'I will cooperate if you do,' we simply follow this line. Perhaps it is worth noting that conditional cooperation can be specially efficient in structured populations [6].

When extending the model towards more reasonable, realistic situations we should not forget the issue of time which could be a crucial problem. More precisely, the repercussions of our present strategy may come later hence we do not necessarily face the consequence of our behavior immediately. This feature is part of the general problem of long-term investment, actually investing in science research also belongs here [7], but it could have interesting consequences regarding pattern formations in spatial systems when social dilemmas are concerned [8].

But most importantly, we should consider the fact that there are several different consequences of global warming such as floods, sea levels rising, wildfires, water stress, melting ice, or impacts on agriculture including crop changes, which influence countries differently. It is easy to realize that some regions are more vulnerable to certain consequences and are less affected by others. In this way we are not facing one problem but rather a branch of dilemmas that need to be solved. These can be modeled more appropriately by using interdependent networks of participants [9,10]. The presence of different, specific problems here may involve the danger of unequal risk thresholds.

Summing up, we have a lot of work ahead of us and I am confident that the authors' standard model will stimulate further thinking and research in this exciting field. Albeit they failed to stress this, but their approach and their conclusions could also be very helpful for other global problems like overfishing, environmental pollution, or generally the overuse of natural resources. We can just hope that the scientific advisors of policy-makers will read their paper.

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