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The evolution of cooperative versus non-cooperative governance of small-scale fisheries

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Abstract— **Small-scale fisheries (SSF) around the world are often organized in patron-client relationships (PC), where fishers deliver fish to a fishbuyer who sells it at regional markets. PCs have recently been criticized as being unequal, exploitative and unsustainable. Many governments have thus developed measures to promote fishing cooperatives. Despite these efforts, PC relationships appear to be increasing globally. The aim of our work is to shed light on why this social organization is very persistent. To this end we combine in depth empirical research on fishbuyers and fishers in an SSF in Mexico with agent-based modeling. This allows us to test hypotheses about the role of actor characteristics, such as their social skills, and the resources, as well as the institutional environment in which these interactions take place, for the establishment and persistence of PC relationships versus cooperatives.**

I. Introduction

Small-scale fisheries around the world are often organized in patron-client relationships (hence forth PC), where a fishbuyer (the patron) provides loans to fishers (the clients) who in turn deliver their fish to the buyer who sells it at local or regional markets [1]. This relationship goes beyond the commercialization of the fish by providing monetary security and insurance to the fishers in times of personal needs or hardship. In recent years, they are being increasingly criticized as unequal, exploitative and unsustainable. Fish-buyers can strongly influence the choices and actions of fishers because of the dependency of fishers' livelihoods on their patron. It has been hypothesized that this relationship can contribute to overfishing as fish-buyers determine fishers' target species and effort based on market demands rather than the condition of the fish population [1]. Governments around the world have thus introduced policies to foster the establishment of fishing cooperatives (hence forth Coops) as an attempt to move away from PC relationships towards more cooperative governance arrangements such as Coops. However, the introduction of Coops has often failed indicating a high resistance of PC relationships. Globally, PC relationships within small-scale fisheries appear to be increasing.

The aim of our work is to shed light on why this social organization is very persistent and which conditions could facilitate social change towards more cooperative, and possibly more sustainable, governance of small-scale fishers. The interplay of social and ecological factors and processes for shaping the dynamics of cooperation in natural resource management is a fundamental question underlying the development of sustainable social-ecological systems [2], [3]. To this end we address the question which social and ecological factors influence the evolution of a PC versus a Coop. We hypothesize that attributes of the fishers and fishbuyers, such as their social skills and reliability as well as the loyalty between a fisherman and his fishbuyer, or fishers within a Coop, are important factors for determining whether PC relationships or Coops will dominate a fishing community. We base these hypotheses on expert knowledge and extensive empirical research within fishing communities in Baja California, Mexico (e.g. [4]) as well as insights from the study of self-organization in common pool resource management [5].

II. A Model of Small-Scale Fisheries Governance

In the following we briefly describe the model following the overview section of the ODD+D protocol [6]. The purpose of the model is to enhance understanding of the social and ecological conditions that facilitate the establishment of cooperative governance arrangements in small-scale fisheries (such as Coops) versus the commonly found non-cooperative arrangements (fishers working for fishbuyers). The model has two types of human agents: fishers and fishbuyers, one ecological entity: a fish population and an economic entity: a fish market. Fishers can work with fishbuyers or form a Coop with other fishers. All agents are characterized by the attributes social skills, managerial skills, reliability and fishing skills, and the state variables financial capital and loyalty. The fish population is modeled using a standard logistic growth function.

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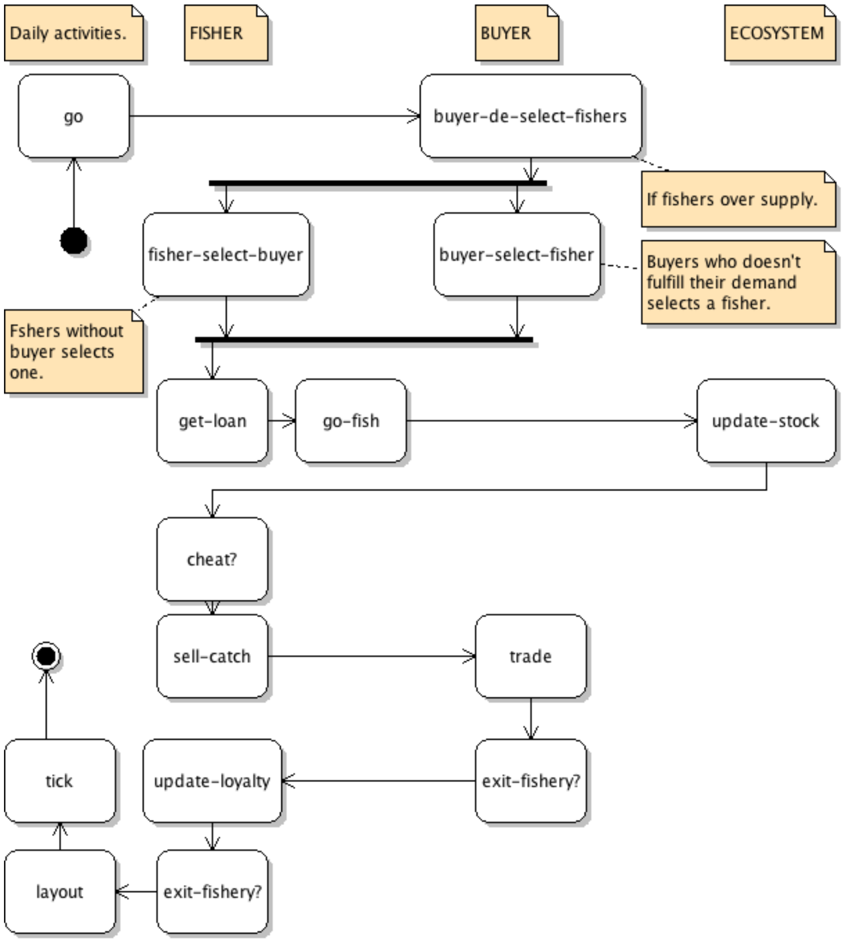

Fig. 1 UML activity diagram of daily activities. A coop or a fishbuyer enter the fishery every 3 years.

At selected intervals (e.g. every three years) the fisher with the highest financial capital can become a fishbuyer and start searching for fishers to work with him. Fishers will select a fishbuyer to work with based on his social skills and the price he offers. The fishbuyer will select a fisher to work with based on its reputation, which is a combination of its fishing skills and reliability. At every daily time step the buyer will assess whether he needs to increase or decrease the number of fishers he works with (see figure 1 for an overview of the scheduling of activities within a daily time step). If needed, he will get rid of the fisherman with lowest loyalty. A fisher will select a buyer that has expressed demand if he is not already working in a Coop. At the same interval five random fishers get together to form a Coop. The Coop provides the financial means to go fishing and sells the fish to the wholesale market. Fishers have to pay back the loan they received as well as a coop fee. Successful interactions between fishers in a Coop will increase the loyalty of the fisher to the Coop.

Each day the fisher will get a loan from the fishbuyer or the Coop he is working with to go fishing. He fishes and the fish stock decreases. The fisher can sell his catch to the fishbuyer or bring it to the Coop respectively; or cheat and sell it to another fishbuyer offering a higher price. The decision to ‘cheat’ is based on the fisher’s reliability and its loyalty to the fishbuyer or cooperative. Loyalty between two agents increases with every successful interaction, i.e. when the fisher does not cheat, and decreases with cheating. A fishbuyer or Coop will sell all the received catch to the market and pay their fishers. Fishers pay back their loan if they did not cheat. Fishbuyers or coops whose budget goes below zero exit the fishery.

The model was calibrated such that when keeping everything equal, e.g. no heterogeneity in skills, PC relationships and Coops had an equal chance of establishing. The model is also calibrated such that the fishery is sustainable when 50 fishers are actively fishing, i.e. they take out fish at a fixed effort, in a community of 100 potentially active fishers.

To operationalize this question we develop an agent-based model (ABM) of fishers and fishbuyers in a small-scale fishing community to study the social and ecological conditions, under which cooperative versus PC strategies can establish and persist. An ABM is suitable because it allows us to explore attributes of both individual fishers and the community in order to assess their relevance for the establishment of Coops. The study is innovative in that it studies natural resource use and management taking multiple levels of governance into account (fisher to fishbuyer to market versus Coop to market). This allows us to study the impact an intermediary level i.e. the fish-buyer (linking fishers to the market), has on the sustainability of a small-scale fishery and the well-being of the community (see Crona et al. (2010) for an empirical investigation of the role of fish-buyers in small-scale fisheries in Kenya).

III. First results – the coexistence of PC and Coops in a community

In the following we show first model explorations that investigate how PC and coops evolve. Under the given setting the number of fishers equilibrates around the sustainable level of 50 fishers with slightly more fishers in Coops than PC. At this point no more PC or Coops can successfully enter the fishery because they will not be able to earn enough to survive. Coops and PC however differ quite strongly in their loyalty. It grows strong in the Coops because they are persistent, i.e. they do not go out of business and form again as often as the PC. Particularly those that were in the fishery from the beginning can continuously build up loyalty while new ones are struggling which is visible in the fluctuations. The PCs fluctuate stronger and thus the loyalty of their fishers remains at a lower level. As a result of the social dynamics the fish stock converges to the optimal level (Figure 3, left); however the community, which had a rather equal distribution of wealth at the beginning, develops into a community with a high level of inequality (Figure 3, right).

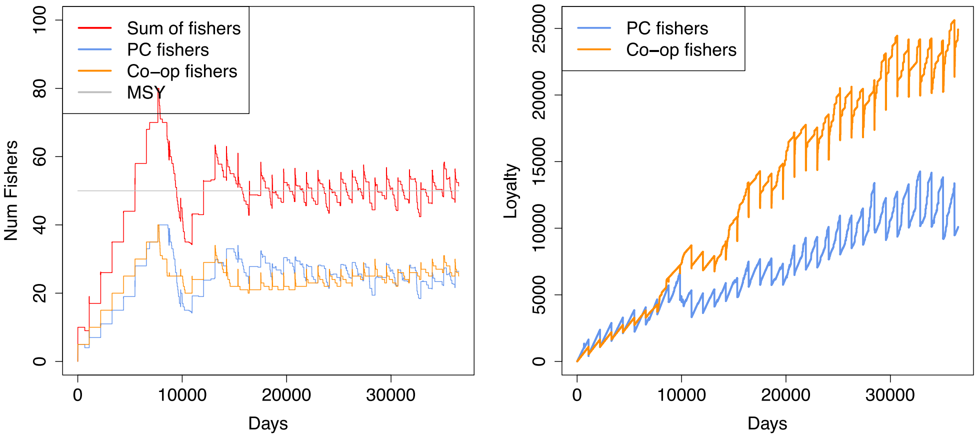

Fig. 2 Number of active fishers in PCs, Coops and the community (left); loyalty of PC and Coop fishers. Scenario settings correspond to the calibrated conditions of generating coexistence of PC and Coops. However, these scenarios include variable prices offered by the fishbuyers. The price acts as an incentive for cheating. Average of 10 runs, cheating depends on reliability only.

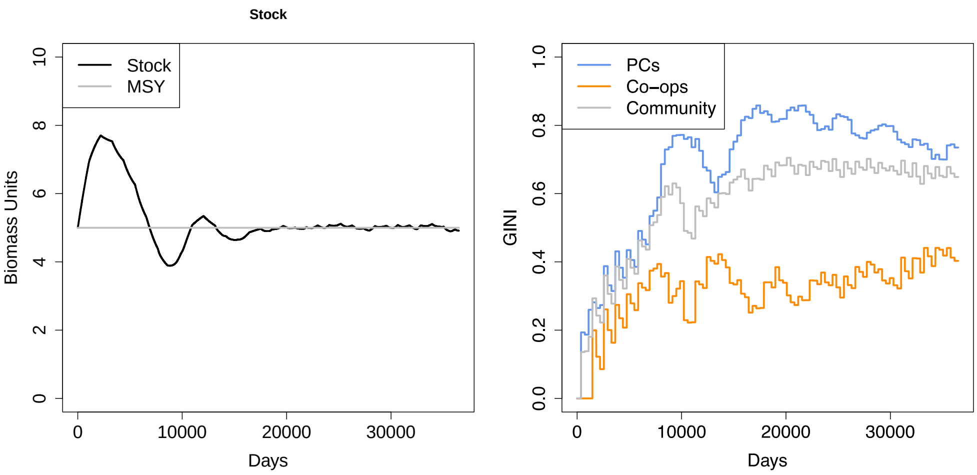

Figure 3: Size of the fish stock over time (left), Gini index (measure of inequality in the community) for PC, Coops and all active fishers in the community. Scenario settings as in Figure 2.

IV. Discussion

These preliminary results show the behavior of the model under very homogenous settings (all agents are initially the same) which is our basis to deploy the model to investigate the effects of social and ecological factors on the social structure of the fishing community and their consequences for the well-being of the community and the state of the fish population. These factors include agent attributes such as managerial skills, social skills and community attributes such as inequality in assets at the beginning of the simulation as well as ecological characteristics such as the growth rate of the fish population or fluctuations in fish abundance. The first results show the implications of variable price offered to the fishers on the generation of loyalty between fishers and fishers and fishbuyers. The model is consistent in its behavior and even with these very equal settings shows some interesting differences between PC and Coops that we will investigate further.

The model builds strongly on empirical data and knowledge that informed the hypothesis, particularly which variables are considered relevant for explaining the performance of PC and Coops, as well as the model structure, parameterization and calibration. We for instance use information on the average number of fishbuyers in this community and the general level of cheating obtained from interviews with the main fishbuyer to calibrate the model. Extensive sensitivity analysis and the use of empirical data for validation (where possible) will be performed to test the robustness of the model. Already at this early stage the joint process of model building has sharpened the analytical approach to the case study and has raised numerous additional questions that will be addressed in future field work. The close cooperation between field experts and modelers was perceived by both as a very enriching experience, and a promising way forward, to address complex real world problems in these complex social-ecological systems (SES). Ultimately we hope that our results contribute to understanding of social and ecological factors and their interactions that can keep SES trapped in a particular governance structure and to identifying leverage points for supporting the establishment of Coops in small-scale fisheries around the world.

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