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Evolutionary cooperation in transboundary river basins

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Cooperation in transboundary river basins can make water resources systems more efficient and benefit riparian stakeholders. However, in a basin with upstream and downstream stakeholders that have different interests, non-cooperative outcomes have often been observed. These can be described by a one shot prisoners' dilemma game where non-cooperation (defection) is a dominant equilibrium strategy. However, cooperative outcomes have also been observed in several transboundary settings, such as the Lancang-Mekong River Basin (LMRB) in Asia. Such cooperation motivates our research effort to refine relevant game theoretic descriptions to account for the evolution of players' behaviors, from conflict to cooperation. In this study, a repeated game model is proposed to analyze evolutionary transboundary cooperation. A generalized evolutionary cooperation pattern with four stages is summarized, starting with non-cooperation and ending with in-depth cooperation. The LMRB and three other typical transboundary river management case studies are chosen to validate our theoretical findings. Upstream and downstream stakeholder behaviors are analyzed for these case studies, in accordance with a game payoff matrix that accounts for incentives to cooperate. The results indicate that patience and incremental benefits can lead stakeholders to adopt a cooperative equilibrium strategy if appropriate institutional mechanisms are in place. Such mechanisms can be developed through negotiations that recognize the wide range of stakeholder interests that may influence the decision to cooperate. Our analysis suggests that game theory can provide useful insights into the conditions and institutional mechanisms that foster cooperative strategies for managing transboundary water resources.