

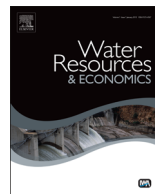


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Exogenous regulatory institutions for sustainable common pool resource management: Application to groundwater



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ABSTRACT

This paper focuses on introducing and comparing various types of external regulatory institutions for management of common pool resources (CPRs), namely the quota-based management, resource status-based management, tax-based management, and bankruptcy management institutions. The performance of these regulatory institutions in a heterogeneous set of physical conditions is demonstrated using a stylized numerical groundwater exploitation example. Results suggest that the benefits to different types of users as well as the sustainability of the CPR vary by the regulator's choice of management institution. More specifically, quota-based management and CPR status-based management institutions can lead to increased benefits to CPR beneficiaries, prolong the CPR's life, and prevent "tragedy of the commons." In contrast, tax-based management institutions may fail to secure sustainable use of the CPRs. Bankruptcy-based management institutions may also be used toward sustainable use of the CPRs and to increase the benefits to the users; however, their overall effectiveness is not as desirable as the quota-based and resource status-based management institutions, especially when enforcing social justice is an issue of concern for the regulator.

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1. Introduction

Common Pool Resources (CPRs) are defined as natural or human-made resource systems characterized by rivalry and non-excludability properties. Given the characteristics of CPRs and their users [1], possible institutions—sets of formal or informal rules governing the users' behavior [2]—for managing CPRs have been suggested in the CPR literature [1,3–7]. These CPR management institutions are classified into three categories [8].

1.1. *Non-cooperative management institutions*

This category includes the ignorant CPR management planning, based only on individual rationality, in which externalities are completely ignored by the beneficiaries, resulting in the “tragedy of the commons” [9,10]. However, CPR beneficiaries do not always face tragic outcomes in non-cooperative environments, even within the prisoner's dilemma structure [11], normally used for explaining CPR games [12]. In fact, the CPR users can benefit from developing heuristic CPR management plans that are based on learning from past experience to achieve a sustainable CPR. This heuristic behavior allows developing long-term exploitation plans and accounting for the externalities, as opposed to myopic ignorant plans resulting in tragedy of the commons. While heuristic behavior may work in the right direction, it may not satisfy societal objectives and, thus, cooperative management institutions might be formed or exogenous regulatory institutions may be imposed. The analysis of non-cooperative institutions is dealt with in Madani and Dinar [8].

1.2. *Cooperative management institutions*

In contrast to non-cooperative management institutions under which CPR beneficiaries' decisions are based on individual rationality, under cooperative management institutions, parties base their actions on group rationality. To secure a sustainable use of a CPR, communities or cooperating groups of users are formed and develop exploitation plans, which minimize the externalities and increase the gains to all parties in the long run.² The analysis of cooperative CPR management institutions is the subject of Madani and Dinar [13].

1.3. *Exogenous regulatory institutions*

To prevent overuse and congestion, regulators may intervene by altering exploitations, assigning ownership rights, or enforcing various CPR governing rules. Targeting those beneficiaries who base their actions on individual rationality and ignore the externalities and the long-term effects of their use on the CPR, these external regulatory institutions prevent users from being pushed into a prisoner's dilemma game to avoid the tragedy of the commons. Exogenous regulations are effective only when they are fully enforced (with full obedience on the part of the beneficiaries). Elaboration on the exogenous institutions (regulations) and their effectiveness are the main objectives of this paper.

By introducing various regulatory institutions, and using a stylized numerical groundwater example, the paper recognizes different alternatives to increase the CPR benefits, while preserving the CPR. One of the major contributions of the paper is considering different behaviors of the users in examining the effectiveness of various exogenous regulatory institutions. Considering that exogenous regulatory institutions may impact differently users with different behavioral characteristics, incorporating different behavioral characteristics of the users in policy analysis helps developing effective regulatory institutions to secure sustainability of CPRs. Thus, the paper derives useful lessons for CPR governance and discusses their policy implications.

² Within cooperative management institutions CPR users may benefit from markets and trading rights to increase their benefits.

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