Inequality and Collective Action in the Commons

by

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Abstract:

[1] The impact of inequality on the ability of human groups to undertake successful collective action is investigated with special reference to overexploitation of common property resources. An attempt is made to articulate the empirical evidence, drawn mainly from social science studies, with relevant arguments that can be derived from economic theory. In voluntary provision problems, inequality has an ambiguous impact on the feasibility of the efficient outcome, while in regulated settings it tends to reduce the acceptability of available regulatory schemes.

I. Introduction

Increasingly during the last decades, the development literature has emphasized the important role of social groups and communities to solve a wide range of economic problems that neither the market nor the state can effectively tackle alone. These problems include the production of local public utilities, the internalization of ecological externalities, the guaranteeing of credit risks vis-à-vis formal lenders, the insurance of poor people against various kinds of contingencies, etc… [see, for instance, Hayami and Kikuchi, 1981; Kimball, 1988; Udry, 1994; Coate and Ravaillon, 1993; Fafchamps, 1992; Platteau, 1991; Ostrom, 1990]. The question as to which factors are more conducive to successful collective actions has therefore recently received a lot of attention from a large number of scholars in different social sciences. Probably the most salient conclusion which emerges from these works, including the works of economic theorists, concerns the crucial role of group size: the smaller the group the stronger its ability to perform collectively [for recent surveys, see Hardin, 1982, Sandler, 1992; Baland and Platteau, 1996].

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A more debatable issue concerns the role of inequality. While this issue has been largely obfuscated in many field studies because it was confused with that of the group size (a small group tends to be considered as effective largely because it is homogeneous), there has recently been a flurry of writings examining the impact of inequality per se on collective action. The way was opened in the mid-sixties when Olson (1965) contended that more inequality may favour the creation of public goods. Other authors have followed suit by showing the positive role of inequality in a wide variety of fields of economics. For instance, oligopolistic collusion, military alliances, international responses to terrorism, or regional schemes for economic integration may be facilitated by the existence of a large firm or nation; the presence of a dominant shareholder may limit free riding in the monitoring of managers by shareholders; the participation of well-off farmers in rural cooperatives may enhance their efficiency, etc. [see, e.g., Sandler and Forbes, 1980; Olson, 1982; Sandler, 1992; Braverman *et al*., 1991]. Of late, some sociologists who have adopted an individual methodological approach have also started to investigate the same issues and their discussions bear strong similarity to those found in the economic literature [see, in particular, Oliver *et al*, 1985; Oliver and Marwell, 1988; Heckathorn, 1993].

The purpose of this paper is to clarify the contribution that economic theory can make towards understanding the impact of inequality on the prospects of collective action with specific reference to the use of common property resources. More precisely, we will argue that there exist a number of critical factors that determine whether inequality promotes or discourages collective actions, particularly those aimed at preventing overexploitation of natural resources. In order to make the presentation more vivid, the various points will be illustrated by referring to a range of concrete situations where collective action is aimed at managing such resources. In addition, whenever possible, findings from in-depth case studies by socio-anthropologists will be mentioned. Since these findings usually conceal the true nature of the collective action problems involved, an effort will be needed to better articulate the available evidence theoretically.

This paper is made of three sections. In section 2, we discuss various conceivable ways in which inequality in wealth distribution can affect the prospects for collective action in the commons. In section 3, attention is focused on the effects of inequality in decentralized settings while in section 4 the possibility of social regulation is allowed for. Modes of regulation in which inequality matters most receive primary attention. A final section briefly summarizes the main findings.

2. Inequality in the context of the commons

As will become clear in the following sections, what really matters for collective action in a common property resource (henceforth called CPR) is the way different participants share in the benefits and the costs resulting from its use. In a static perspective, the distribution of rights of access to the CPR and its benefits tends to reflect the distribution of wealth endowments.[2] Thus, some users enjoy better access to the CPR because they possess a relatively large amount of the production factors required to exploit it (capital equipment, control over labour power, better skills and knowledge, etc.). This advantage may originate in past accumulation of wealth, greater network of social relations, better education, or in a privileged access to markets where critical inputs such as credit and manpower can be obtained. In reality, many of these factors are narrowly interlocked. To take the example of credit, influential individuals are often found to gain a disproportionate share of the funds available because they have better collaterals to offer, greater trustworthiness, stronger connections with leading persons in credit-giving agencies or better information about available credit opportunities. Regarding labour, their enviable position may result from the fact that they have sufficient cash to pay advance money or give consumption credit to hired workers, that they have many social relations or large families to relay on, etc.

However, when the distribution of access rights is so unequal that it loses its legitimacy, relations between poor and rich users tend to be unstable and hostile with the consequence that the latter do not feel any more secure about the future state of their rights. They may then react by exploiting the resource as intensively as possible without any regard for the viability of the resource base [Boyce, 1994; Baland and Platteau: 177; Baland and Platteau, 1996: 251-4, 280].

Furthermore, many CPR problems require a dynamic perspective to be properly analyzed, particularly when there are important conservation issues involved. Clearly, the behaviour of the different participants in the CPR depends on the structure of their time preferences. Users with a shorter time horizon tend to adopt strategies which yield more immediate results, and to disregard long-term considerations in resource conservation. The initial distribution of wealth also matters here since it affects the variations in time horizons either through the intervention of survival constraints or through the availability of outside economic opportunities.

First, the level of wealth of the poorer users may be so low that the behaviour required for the efficient use of the CPR violates their survival constraint. This constraint artificially reduces their time horizon since they are then forced to attach considerable importance to their present incomes. As a result, they are not willing to undertake conservation investments or endure present sacrifices in the form of self-restraint in the use of the resource even though such actions would increase their future permanent income.

A second reason why rates of time preference may vary among CPR users lies in the fact that some of them may have better access to outside economic opportunities than others. For those enjoying such opportunities, the discounted value of their

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[2] Note that privileged access to a CPR does not necessarily take on the form of a comparatively large number of harvesting units put into use (boats to catch fish in a water space, labourers to collect fuelwood in the forest, animals to graze on the pasture, land parcels in an irrigated scheme, …) but may also manifest itself in the ability of some users to occupy strategic positions in the CPR (e.g., privileged access to good fishing sites, proximity to wells in grazelands) which secure them a large share of the benefits.

future income flows from the CPR may, at some point in time, fall below that of alternative incomes available. Since they anticipate that they will then shift to the alternative occupation, they have an incentive to overexploit and deplete the CPR. On the contrary, users deprived of such outside opportunities attach a higher value to the future state of the resource.

The relation between wealth distribution and outside opportunities is actually ambiguous. Indeed, on the one hand, rich people usually have easier access to alternative opportunities due to their better endowments in human and social capital and access to financial markets (see supra). On the other hand, their low resource base may force poor people to actively seek off-farm employment. Yet, in this respect, it is noteworthy that poor people are less likely to neglect the conservation of the resource when they have available to them outside income opportunities. As a matter of fact, their employment prospects may be so uncertain that they are keen to preserve access to local CPRs through adequate resource use behaviour. A widespread strategy to this end consists for migrant workers of leaving the core of their family in the native village. By contrast, rich migrants tend to move permanently to new locations and to cut off or neglect traditional ties with their village.

3, Collective action in decentralized settings

By decentralized settings we mean situations in which agents freely interact without any intervention by a regulatory authority. Side-payments among agents may or may not take place in such settings. In the following discussion, we will first assume that inter-individual transfers are impossible to relax this assumption at a later stage.

Collective action in a CPR can take on two forms: the provision of a public good--such as the construction of a collective infrastructure (water control structures in irrigation schemes or drainage networks in watershed management schemes, for example) or the protection of the CPR territory against outsiders--and conservation measures that imply self-restraint on the part of resource users [see, e.g., Ostrom, 1990]. Whatever the actual form taken by collective action, the analytical problem which it raises in decentralized settings is fundamentally the same. Indeed, the voluntary contribution to collective action by an individual depends directly on the extent to which he can internalize the benefits resulting therefrom. When assessing the impact of inequality on the success of collective action, two distinct effects are therefore at work. On the one hand, as Olson has emphasized, the greater the share in the benefits of a collective action for any single member, the greater the propensity of the 'large' member to bear the costs involved [Olson, 1965: 33-4]. On the other hand, when inequality is large, "small" users may internalize such a tiny share of the benefits that they are not prompted to participate in the collective effort. Increasing inequality thus enhances the incentive of the big users to voluntarily contribute and simultaneously encourages the small users to free ride on the former's contributions.

Consequently, the net impact of inequality on collective action will hinge upon the respective strengths of these two opposite effects [see also Heckathorn, 1992].

The above conclusion, it must be stressed, is at variance with the so-called 'neutrality theorem' according to which the private provision of a public good is unaffected by a redistribution of income. This holds regardless of differences in individual preferences and despite differences in marginal propensities to contribute to the public good [Warr, 1983; Bergstrom et al, 1986]. Some conditions are, however, attached to this striking result which reduce its relevance in many applications and, particularly, in common property problems. First, the public good must be 'pure', in the sense that everyone is provided with exactly the same amount of the same good (when it is produced) and regardless of whether he personally contributed or not. Second, the neutrality theorem holds only when it is assumed that income redistribution does not change the set of contributors. In other words, after redistribution, all agents concerned continue to contribute to the public good.

These two restrictions are too strong for the problem at hand. On the one hand, most 'common properties' are not pure public goods in the above sense. Typically, the shares in the benefits provided by the CPR are unequally distributed since they depend on access rights as previously discussed. Moreover, as will become clearer in the following illustrations, the individual incentive to 'contribute' does not vary monotonically with the aggregate amount of contributions made by others, particularly in the presence of non-convexities or threshold phenomena. On the other hand, as has been hinted at in the beginning of this section, an important possibility that will receive much attention in this paper is that redistribution of access rights may prompt poorer (richer) users to stop (start) contributing altogether to the management and conservation of the CPR. The set of contributors cannot therefore be taken as constant.

Since the production function underlying the common property crucially affects the way inequality bears upon collective action, different cases will be discussed. Let us begin by considering the more standard situation where this technology is convex before turning to situations characterized by non-convexities.

Voluntary contribution with convex technologies

Consider a fishery to which four fishermen have access. These four fishermen play a simultaneous game in which each of them must decide how many boats he will put out at sea. The relationship between the total number of boats, total net income and average income per boat is given in Table 1.

Table 1. Relationship between total level of appropriation efforts and total net income on a CPR with decreasing returns

Number of boats	net total income	net average income per boat
1	2	2
2	6	3
3	9	3
4	11	2.75
5	12	2.4
6	11.5	1.92
7	10.6	1.51
8	9	1.125
9	7.3	0.81
10	5.5	0.55
11	0.55	0.05

Given the technology described in the table, the game has a unique Nash equilibrium in which two fishermen put out two boats each while the other two put out three boats. The total number of boats thus operated in the fishery (10) is clearly in excess to the social optimum which requires that only 5 boats be used.

This tendency to over-exploit common property resources characterizes what is known, since Hardin (1968), as the Tragedy of the Commons. It is important insofar as it applies to numerous and well-documented real world situations in which common property resources have been manifestly depleted, usually under open access conditions. The inescapable logic of the argument has been used to explain such varied situations as the Sahelian desertification, the destruction of Amazonian forests, the depletion of many marine fisheries in developed countries, the near extinction of blue whales, etc.[3]

An interesting question to then ask is whether any external constraint that has the effect of limiting the number of boats which some fishermen can own is susceptible of reducing the extent of overexploitation of the fishery by altering the distribution of access rights. Typically, rationing on the credit market deprives a number of operators of the funds necessary to acquire as many boats as they would like. In table 2, the first column shows all the possible configurations of a constrained access by fishermen to boat ownership, under the assumption that the total credit available allows the financing of at most ten boats. For example, (1,1,1,7) means that three fishermen can buy only one boat, while the last one can buy up to seven boats. The second column gives the respective values of the Gini coefficients pertaining to all possible distributions of the credit constraints. The resulting Nash equilibria of the instantaneous game where, given his credit constraint, each fisherman has to choose the number of boats to operate are described in the third column. What is shown in the last column is an efficiency index of

[3] Note indeed that in our examples the number of users is fixed, which implies that there is some sort of regulation in the communities concerned. Genuine situations of open access will not be considered in this paper, since they do not refer to a well-defined group and, therefore, do not allow for strategic interactions among users.

the Nash equilibria: it is calculated as the ratio of the total net income obtained in the final situations to the (first-best) optimum.

Table 2. Impact of heterogeneity on the total amount and the distribution of appropriation efforts when increased efforts are impossible

Distribution of credit constraints	Gini index of the distribution of credit constraints	Equilibrium allocation of boats	Index of the efficiency achieved in the final allocation (%)
1 1 1 7	.45	1 1 1 4	88.0
1 1 2 6	.40	1 1 2 3	88.0
1 1 3 5	.35	1 1 3 3	75.0
1 1 4 4	.30	1 1 3 3	75.0
1 2 2 5	.30	1 2 2 3	75.0
1 2 3 4	.25	1 2 3 3	58.0
2 2 2 4	.15	2 2 2 3	58.0
2 2 3 3	.10	2 2 3 3	45.0

The striking feature that emerges from Table 2 is the following: given the users' inability to reach a binding agreement together, the most desirable situations obtain when the distributions of credit constraints are the most skewed. In these cases, indeed, the value of the efficiency index works out to 88%, which means that maximum inequality leads to an outcome that is remarkably close to the social optimum. This represents a significant improvement since the value of this index in the unconstrained Nash equilibrium (2,2,3,3) is as low as 45%. Furthermore, a comparison of the second and fourth columns reveals that there is a perfect rank correlation between the measure of efficiency in the equilibrium situations and the skewness of the distribution of credit constraints (as measured by the Gini coefficient). In particular, it is worth noticing that the most equitable *ex ante* distribution of credit constraints does not lead to any improvement in efficiency.

Equally noticeable is the fact that the distribution of income that obtains when inequality is maximum is a Rawls-improvement over the distribution of income in the most equitable situation or the unconstrained Nash equilibrium. As a matter of fact, the poorest fishermen earn a higher income in the most inequitable situation (1.51) than in the most equitable one (2x0.55) although they operate fewer boats. Rather paradoxically, constraints or factor market imperfections that limit the access of some users to capital or other critical inputs may thus allow inequitable distributions of endowments to increase the incomes of the most constrained users.

As hinted at in the introduction, there is actually a wide array of constraints that can yield the above effect. The administrative distribution of harvesting licenses by a central authority provides an interesting application of our central argument. Indeed, if the state distributes the available licenses in an unequal way among the operating fishermen, it would create a situation in which the bigger license-holders have an incentive to self-limit their use of the licenses. In other words, a number of those licenses would be left unused, and this can lead to an improvement of the incomes of the small license-holders.

The central result achieved in the foregoing discussion is not specific to the particular technology implicit in Table 1. To see this, let us adopt a slightly more general formulation of the problem. Two agents exploit a common property resource and share the benefit in direct proportion to the relative amount of appropriation efforts they have chosen to put in. If n1 and n2 are the amounts of appropriation effort deployed by the first and the second resource user respectively, the total (net) output can be written as Y (n1 = n1) where Y" <0. The profit accruing to agent 1 is therefore

(1)

Each user maximizes his profit-taking as given the amount of effort chosen by the other user, and the resulting Nash equilibrium is determined by the two following first-order conditions:

(2)

Let us assume that the Nash equilibrium corresponds to (n1*,n2*), giving rise to a total amount of effort of (n1*+n2*), where n1*=n2*. Bearing in mind that the agents face a Tragedy of the Commons, we know that Y' <0.

Suppose that a constraint has the effect of reducing the second user's amount of effort from n2* to n2*, thus forcing a disequalizing change in the distribution of access rights. It can then be shown that the first user will not respond to this disequalizing change by increasing his own effort commensurately with the forced reduction of the second user's effort. Indeed, if the first user reacts by increasing his amount of effort so that (n1 + n2) does not decrease, a rapid inspection of equation (2) reveals that his first-order condition will be violated: keeping (n1+n2) constant, the derivative of the first user's profit function with respect to n1 is bigger and multiplies Y', of negative value). Moreover, once user 1 has adjusted to user 1's reduced effort, a further reduction imposed in the latter's effort will again be followed by a fall in total effort (user 1 does not compensate the decrease in user 2's effort). Therefore, the more unequal the distribution (the more rationed the effort of one user relative to the other), the more effective the use of the CPR. Note that, as happens in our numerical example, the income of the second user may well increase. On the other hand, it needs not even be the case that the first user will increase his effort in response to the forced decrease in the effort of the second user. Whether he will actually do so depends on the shape of the production function. The above analysis can be easily generalized to situations involving more than two agents.

Voluntary Contributions with Non-Convex Technologies

When the technology used is non-convex, wealth inequality bears upon the configuration of equilibria that obtains. A simple example may illustrate this. Assume that three fishermen have different rights of access to a fishery, which arise from unequal endowments in fishing equipment. One big fisherman has four boats while two small fishermen have only one boat each: this distribution of endowments is denoted as (4,1,1). Before putting their boat(s) out at sea, the fishermen have to make a decision about the size of the meshes of the nets to be operated from the boats: they may use nets with either small or large meshes (choice is binary). The use of small meshes is ecologically destructive (its generalized use causes future fish catches to decline abruptly), yet refraining from employing them is rewarding for an individual only if a sufficient number of users follow suit. Net incomes per boat vary depending upon the number of boats operating small-meshed nets, as indicated in Table 3 below.

Table 3: Returns per boat in a fishery with two fishing techniques

number of boats using small meshes	number of boats using large meshes	average income per boat using small meshes	average income per boat using large meshes
0	6	-	11
1	5	10 (13) ((13))	10 ((6))
2	4	9 (12) ((9))	5 ((4))
3	3	7	3
4	2	6	2
5	1	5	1
	0	4.5	-

For instance, it can be seen (ignoring figures indicated between brackets) that when three boats use small meshes and the three other boats use large meshes, each of the former will get a net income of 7, while each of the latter will get only 3. By convention, this payoff structure is written P(3,3)=(7,3). Let us now start with the situation in which all six boats use small meshes and earn 4.5 units of income each. If one of the fishermen owning only one boat decides to shift to large meshes, his income falls from 4.5 to 1 unit. They therefore have no incentive to deviate. In contrast, by equipping his four boats with large meshes, the big fisherman actually increases his total income from 18 to 20 units. He therefore deviates. We can conclude that, given the assymetric distribution of boat ownership assumed, the situation in which every fisherman uses small meshes is not a Nash equilibrium. Knowing that using nets with large meshes is thus a dominant strategy for the big fisherman, each small fisherman also adopt the ecologically-friendly technology: in this game, there is only one Nash equilibrium where all the six boats operate the large-meshed nets. This favourable result follows from the fact that the big fisherman has a large enough endowment to allow internalization of a sufficient fraction of the externalities to induce him to adopt the conservative technique irrespective of the choice made by the other fishermen.

However, if distribution is more egalitarian, say (2,2,2), there then exist two Nash equilibria, one in which every boat uses small-meshed nets (an inferior outcome) and the other in which all boats use large-meshed nets (the Pareto-dominating equilibrium). The game now corresponds to a coordination game and there is a priori no compelling reason for one equilibrium to emerge.

In the above example, inequality is beneficial in so far as it leads to a unique equilibrium in which everyone "cooperates" by using nets with large meshes whereas with an equal distribution, the Pareto-dominating equilibrium is only a possibility. One may easily conceive of other situations where equilibrium configurations are different, yet the equilibrium under the more unequal distribution remains more efficient. For instance, inequality may yield a partial cooperation outcome while the more equal distribution leads to a Tragedy of the Commons. This situation obtains when the payoffs in Table 3 are changed in the following way (whenever payoffs are modified, they are indicated between single brackets in the appropriate cells): P(1,5)=(12.5). In this new situation, with an equal distribution of assets, there is a unique equilibrium and it corresponds to the Tragedy of the Commons: the dominant strategy for every fisherman is to use small meshes. By contrast, when the distribution is (4,1,1), the big fisherman is prompted to use large meshes on all his nets, whatever the choice made by the others. The latter continue to use small meshes and free-ride on the big fisherman's efforts.

From the foregoing account, it should not be inferred that inequality necessarily promotes collective action. It is easy to construct examples in which the equilibrium outcome is unaffected by the distribution of assets: this happens, for instance, if P(1,5)=(13,6) and P(2,4)=(12,4). More generally, the relationship between inequality and efficiency in resource use is not monotonic. To see this, let us keep the same payoff structure as that obtaining in our last example, but modify the asset distribution from (4,1,1) to (3,2,1). As before, the small fisherman clings to small meshes, yet, what the other two fishermen will do cannot be predicted with certainty. Indeed, they face a coordination game characterized by two equilibria, one in which both fishermen use small meshes, and the other in which they use large meshes. When they use large meshes, the outcome is more efficient than that obtaining under the more unequal distribution (4,1,1) since there is now only one free-rider. It is striking that the former outcome even Pareto-dominates the latter.

In the last example, resource use efficiency can thus be greater with the more equal distribution. This result actually arises from the fact that one of the small fishermen, following the enlargement of his asset base, has now become able to sufficiently internalize the benefits of his self-restraint as to be induced to use large meshes, provided that the biggest user does likewise.

This points up the importance of the role played by the small agents that we have underlined in the beginning of this section. In the same logic, it may be shown that situations exist in which inequality just destroys the possibility of an efficient equilibrium. This happens if, in table 3 (see the figures indicated between double brackets), the following payoffs are changed: P(1,5)=(13,6) and P(2,4)=(9,4). Under the (2,2,2) distribution of entitlements, the users face a coordination game, and there are two equilibria (in pure strategies): in the first equilibrium, all agents use small meshes, and in the second one, they all use large meshes. Under the (4,1,1) distribution, there is a unique Nash equilibrium in which all agents use the destructive technology. The same holds true under the (3,2,1) distribution.

At this juncture, it is evident that two parameters play a pivotal role in the determination of equilibrium strategies, namely the biggest and the smallest endowments held by an individual user. To understand why this is so, it is useful to consider the situation in which no cooperation occurs. Such a situation is a Nash equilibrium if and only if the largest endowment is not sufficiently large to induce its owner to deviate. This is clearly the problem raised by Olson in his 'Logic of Collective Action'. As for the other extreme situation in which everybody, whether big or small, cooperates, it will be a Nash equilibrium if and only if the smallest endowment is still large enough to create an incentive for its owner to cooperate.

Even assuming that small agents have too little incentive to cooperate, it is not certain that generalized free-riding will occur since the big users may still have an interest in cooperating among themselves. Such situations of partial cooperation will correspond to Nash equilibria only if (a) among the cooperating users, the agent with the smallest endowment has not incentive to stop cooperating and (b) among the non-cooperating users, the agent with the biggest endowment has no incentive to join the cooperators.

To conclude, there is nothing as a one-to-one relationship between inequality and collective action and, therefore, Olson's argument cannot be used in favour of inequality in applications pertaining to management of common property resources. Non-convexities are at work in most problems of CPR management and, in the presence of such non-convexities, the impact of inequality is highly sensitive to the characteristics of the technology. Particularly, if the participation of all users is required to sustain the efficient outcome (like with the use of dynamite or cyanide in coral reef fishing), inequality can only make this outcome more difficult to attain. On the contrary, if the efficient outcome requires only a small number of cooperating units, inequality is more likely to yield cooperation than equality. Finally, it is worth emphasizing that there is no such case where inequality destroys collective action while equality necessarily leads to the efficient outcome as a Nash equilibrium. Indeed, as long as per unit benefits increase with the number of cooperating units, starting from the inefficient situation a small user has always fewer incentives to deviate or cooperate than a larger user. Therefore, if the inefficient situation is not a possible Nash equilibrium under an equal distribution, it cannot be one under a more unequal distribution. Thus, the worst case against inequality obtains when equal distribution yields a coordination game while inequality leads to the PD game.

Now, in situations where information is imperfect, cooperation may or may not emerge depending on the way would-be cooperators assess their own proportion in the user population. This is all the more important in situations where they need to coordinate their actions lest partial cooperation should not be possible.

It is useful to further illustrate this point by bringing to light the role of users' expectations. Consider a n-player game in which some players, with few endowments or readily available outside economic opportunities, have a dominant strategy which is to deplete the CPR irrespective of what the others do, while the remaining players are willing to follow a conservation strategy provided that a sufficient number of them behave likewise. As in one of the examples discussed above, this corresponds to an encounter between agents with a Prisoner's Dilemma (PD) payoff structure on the one hand, and agents with a payoff structure typical of a Coordination Game (CG), on the other hand.

Let us assume that resource users meet anonymously, play simultaneously and can only observe past aggregate outcomes. In other words, the assumption is made that agents are broadly able to make out *ex post* whether and to what extent management of the CPR has been successful. This is because if they cannot observe individual actions by other players, they can observe the concrete results that cooperation has produced: an irrigation canal has been more or less well maintained; foreign trawlers have been effectively deprived of access to inshore waters; the spawning area for fish has not been encroached upon; no felling of trees or cutting of wood has happened in the forest during forbidden times; little grazing occurred on the collective fields before the date fixed, etc. As is evident from these illustrations, the members of a large group may be in a position to approximately infer the relative number of individuals who have 'cooperated' or 'defected.'

The structure of the game is such that gains from cooperation and defection for both CG- and PD-type players decrease when the proportion of cooperating members in the group declines. In particular, for both types of players, it is more rewarding to free ride when everyone else cooperates than when only a fraction of the other members do so, and the gains from free riding are at their lowest when defection is generalized. PD players have a dominant strategy which is to defect. As for CG players, their preferred strategy will obviously depend on their expectations regarding the likely behaviour of the other players. They will choose to cooperate if they expect more than a given percentage of the group members to cooperate, otherwise they will defect. Trust is obviously important: for cooperation to prevail on a large scale, it is not enough that a sufficient number of people prefer universal cooperation but it must also be the case that they feel confident enough that their willingness to cooperate is shared by many others too.

Now, the question is whether the cooperative outcome can be sustained on a large enough scale over time. Four different scenarios can emerge. First, from the start, the number of CG-type players and their optimism are high enough to make stable cooperation possible. PD players continually defect and free-ride on the cooperative efforts of the CG players, yet their number is not sufficient to deter the latter from continuing to cooperate.

Second, the actual number of CG players is too low to sustain collective action in the long run. Two sub-cases can then arise. Either, at the start, CG players are pessimistic and no cooperation actually occurs, or CG players are over-optimistic, and they are led, through their negative experiences, to revise their expectations downwards till cooperation is no more worthwhile.

One of the most vivid illustrations of the possibility of PD players overwhelming CG players and thereby destroying cooperative behaviour in the use of natural resources is found in the field of pastoral management. Thus, in Mali, the emergence of absentee herd owners who have outside economic opportunities available to them appears to be a major stumbling block on the way towards pastoral institution-building for sustainable rangeland management. This was a result of the great Sahelian droughts in the seventies when pastoralists were forced to sell their livestock to farmers or, more generally, to wealthier town-dwellers like traders and civil servants. According to a recent evaluation study of the Mopti Area Development Project, "Absentee herd owners favour open access rangelands so that their herds can graze anywhere. They may even use their political influence to prevent pastoral associations receiving legally defensible land rights" [Shanmugaratnam *et al*, 1992: 20]. In Mauritania also, the extent of herd dispossession and absentee ownership is considerable and, like in Mali, it creates major difficulties for pastoral management: "Both Moor and Peul pastoralists have lost large shares of their livestock through sale to absentee herd owners… The abolition of animal taxes since the droughts of 1984-85 and the introduction of property taxes have given further impetus to absentee ownership. Many richer people in the towns prefer to invest in cattle instead of in real estate. Absentee herd owners in Mauritania are mainly concentrated in Nouakchott and a few other towns. They prefer to keep their herds as close as possible to their towns; for instance, the bulk of the herds belonging to owners living in Nouakchott are found within a radius of 100 kilometers around the city. Such concentration of herds in Limited areas contributes to over-grazing and exacerbates land-use conflicts around the towns" [Shanmugaratnam et al., 1992: 25-6]. The above description fits well with other country experiences in Sub-Saharan Africa, for instance Burundi where many cattle herds grazing around the capital city of Bujumbura belong to well-to-do city-dwellers.

Marine fishing is another sector where resource management is seriously undermined by the presence of big actors who enjoy outside economic opportunities. The encounter here is between small-scale (artisanal) fishermen who draw their livelihood from nearby fishing grounds and industrial fishing companies which can easily move their fleets to other, possibly distant fishing grounds[1] or even switch to other economic sectors if fish resources have become too degraded to make their investments in fisheries economically attractive. An immediate consequence of this situation is that industrial operators feel little concerned about conservation of fish resources.

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[1] Just think of the present re-deployment of industrial fleets of European (both Western and Eastern) and Far Eastern origins along the Western coasts of Africa.

As a concrete illustration, consider the conflict which arose during the last decades around mackerel fishing between hook-and-line artisanal fishermen and industrial seiners in the coastal waters of Katsuura in Japan (Chiba prefecture). While the former have been taught from their childhood that catching juvenile fish is a bad thing that jeopardises the future of the resource (a fisherman found guilty of such an act gets a bad name), the latter have systematically caught all the mackerels regardless of their size. This indiscriminate fishing on the part of industrial companies eventually caused the depletion of mackerel stocks not only in Chiba prefecture but in the whole coastal area where these fish migrate (from Izu islands south of Tokyo to the off-shore of Hokkaido Island, northern Japan) resulting in tremendous hardship for small-scale fishermen. The same story has been actually repeated for sardines and tunas and, today, it seems to hold true for skipjacks as well.[2] Unfortunately, examples of this kind are very easy to find all over the developing world.

Of course, there are situations where agents with differing endowments are able to co-exist peacefully. This may happen as long as the PD-type users represent a sufficiently low proportion of the user population. The example which immediately springs to mind is that where village communities tolerate the presence of a few temporary immigrants who do not have the same concern as they do for the conservation of local resources. However, as soon as their relative importance becomes so large as to threaten the viability of these resources, permanent settlers will manifest their will to get rid of them. This is typically the kind of reaction observed in marine communities exposed to migrant fishermen: think, for example, of the aggressive attitudes which recently developed among Bissau-Guinean fishermen against Senegalese migrants once the latter became too numerous in the Bijagos islands' waters, leading to over-fishing of some valuable species (most glaringly, turtles); or of similar attitudes displayed by *Diola* people in Casamance against migrant fishermen coming from northern Senegal (personal observations).

Similarly, a detailed story told by Laurent *et al* shows that in southern Burkina Faso, local *Nuni* people were on quite good terms with *Mossi*, immigrants from the North of the country. However, then pressure of these strangers on local resource became too big, the *Nuni* began to accuse the *Mossi* immigrants of destroying trees, overusing various forest products and mismanaging the land [Laurent *et al*, 1994]. In the latter instance, at least when the *Mossi* tillers want to settle permanently in the *Nuni* villages, there is ground to believe that indictments against them are not always fair: it is not because strangers follow different practices from the locals that these practices are necessarily destructive.

When the number of players is allowed to vary, one cannot exclude the possibility that CG players anticipate the proportion of PD players to rise in a near future. Such expectations, whether well-grounded or not, may lead the former to intensify their harvesting efforts beyond the sustainable level of the resource. Thus, in a FAO project aiming at better management of forest resources in Burkina Faso, there is the fear that depletion by the beneficiaries will start as soon as the hierarchical institutional structure

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[2] Oral communication of Masao Suzuki and Yoshiaki Aziki at the 10th Anniversary Conference of the International Collective for Support of Fishworkers (ICSF), Cebu, Philippines, 2-7 June 1994.

put in place by the project is removed. Since these beneficiaries believe that migrants who do not abide by conservation rules will return to the area in great numbers after removal of this control structure, they would indeed by tempted to cut wood rapidly and without restriction [Laurent and Mathieu, 1995].

There are two other scenarios still to be considered. First, there are situations where the actual number of CG players in the group is high enough to sustain cooperation, yet CG players are pessimistic, in the sense that they expect CG players to be less numerous than they are in reality. Two sub-cases again arise. In the first one, the number of operators in the beginning is high enough to sustain cooperation, and CG players are led to revise their expectations upwards: cooperation can therefore be sustained. In the second sub-case, cooperators are too pessimistic, and their observations of generalized defection confirm their negative expectations.

Note that, if actions are surrounded by 'noises', a move by a small player may be hard to detect by the other players, while a move made by a player with a lot of stakes in the CPR will be immediately noticed. As a consequence, inequality may be conducive to cooperation insofar as it induces big players to act as leaders by taking initiatives, credibly informing other users about their intentions and thereby overcoming self-fulfilling pessimism of would-be cooperators.

Lastly, if we allow CG players to hold expectations of varying optimism, more complex scenarios can emerge. In particular, it may happen that cooperation is initiated by the more optimistic CG players who then act as catalysts to drag other CG players into cooperation at a later stage. Unfortunately, failure is also a possibility if the pervasiveness of pessimism among CG players causes the initial cooperation of a minority of optimists to unravel.

Many experimental socio-psychological studies have revealed that pessimism or distrust can be overcome by fostering communication among the users concerned. For example, in an experimental coordination game with a cooperation threshold (similar to the game displayed above), it has been shown, that, whenever there was a possibility of communication, subjects with no other relations than those defined within the experiment were led to devise a mechanism aimed at ensuring cooperation [Dawes and Thaler, 1988: 193-4]. On the other hand, it is evident from some field experiences that trust can sometimes be gradually built up through acting communication among people who were skeptical of collective undertakings. Thus, in the Gal Oya irrigation scheme in Sri Lanka, this result has been achieved by creating simple interaction frameworks and trust-enhancing situations (small groups operating at a very decentralised level) in which people have strong incentives to cooperate in order to solve day-to-day vital problems under the supervision of external agents acting as 'human catalysts'. It is only in the second phase of the project, when water users had learned to act together with sufficient trust and mutual understanding, that formal regulation mechanisms could be devised and enforced [for more details, see Ostrom, 1990:166-172].

Problems arising from the uncertain outcome of interactions between PD and CG players can also be surmounted if the latter can succeed in integrating the former with the purpose of transforming them into CG players. One privileged way of achieving this transformation is by forcing stranger users to enter into a local web of multiplex and long-term relationships involving reputation effects. In other words, free riders are prevented from playing a single-period game so as to make cooperation possible. A well-documented mechanism to lengthen the duration of the game is the establishment of personal links of friendship or godparenthood[3] [Cordell and McKean, 1986: 95-6; Levieil, 1987: 74-85; Davis, 1983; Hviding and Baines, 1994: 23-5; Acheson, 1987, 1988].

Decentralized Bargaining with Perfect and Imperfect Information

So far, it has been argued that inequality is susceptible of increasing the efficiency of resource use. It must nevertheless be stressed that this does not imply that optimal use is achieved. (This is evident in the example corresponding to tables 1 and 2). In most of our illustrations, we have actually shown that, among several Pareto-inefficient situations, inequality may favour the selection of the least inefficient ones.

However, following Coase (1960), it might be argued that if agents are able to strike deals with each other and, in particular, to make compensatory transfers or side-payments, the efficient solution will be attained. More precisely, when information is perfect and the rights of use are well-defined, in particular all rightsholders are known, decentralized bargaining can lead to the Pareto-optimal outcome. Inequality does not therefore matter: whether agents are unequal or not in terms of their endowments, the socially desirable solution necessarily arises. Upon this reading, our conclusions about the potentially positive role of inequality would be valid only because we have assumed away the possibility of inter-agent transfers.

This assumption is not unjustifiable, though. Indeed, Coase Theorem has invited a number of serious criticisms which largely destroy its relevance (for more details, see Baland and Platteau (1996)). Second, the presence of significant transaction costs resulting from the process of negotiation causes the initial distribution of rights to bear upon the final outcome. Indeed, a change in the initial distribution of rights determines a new configuration of transaction costs and, as a result, a new efficient equilibrium (specific to this new set of transaction costs). Since this kind of costs are usually non-negligible in reality, the above conclusion that inequality does not matter loses much of its relevance in the present context. This said, it is *a priori* difficult to ascertain how transaction costs are going to be actually influenced by the pattern of the endowment distribution. Third, when a small number of agents are involved, information about the

3 A related way to interpret this practice is to consider it as a step whereby members of a dominant group (e.g., a resident group) ensure that all the users of a given CPR share the same values and abide by the same cultural code. Thus, in the above example involving migrant farmers (the *Mossi*) and local inhabitants (the *Nuni*) in Burkina Faso, the latter consider that they must explain to the former "the rules to be respected." Only if the migrants, who"do not know the local deities nor the way to honour them," agree to this can they be accepted among the original inhabitants [Laurent, Mathieu and Totté, 1994: 98].

other's objectives is imperfect and their objectives can differ widely, it can be shown that private decentralized agreements are so inefficient that a centralized decision imposed by a 'bumbling bureaucrat' generally proves superior. This is true even though the latter's decision is based on average expectations about users' objectives [Farrell, 1987].

Information problems are especially serious with regard to benefits and losses which different users draw from conservation practices. This is due to the fact that those benefits and losses are uncertain, occur in future times and it is not clear who is going to be affected. It is therefore not surprising that it is so hard to find examples of inter-agent decentralized transfers aimed at compensating self-restraint in the use of natural resources. Contrarywise, examples about in which compensations are paid for easily identifiable damages inflicted on some users. This is mostly evident in fisheries where gear conflicts are pervasive (as a result of acute competition for fishing space) and are sometimes solved in this way. For instance, in Jinoshima (Japan) in 1840, this type of compensation was offered by the operator of a tuna net unit to yellowtail netters following recognition that tuna-fishing was detrimental to yellowtail-netting in the same waters [Ruddle, 1987: 22]. Even nowadays in the North Sea, a tacit sea code voluntarily abided by many marine fishermen provides that, when there is unmistakable evidence that a fishing unit has caused a damage to another, the former is expected to immediately pay to the latter an indemnity in cash on which both parties have agreed. Of late, a representative of the main organization of Senegalese mechanized boats has offered to compensate small-scale fishermen (operating canoes with outboard engines) for gear destructions caused by (illegal) encroachments of such boats into the coastal water zone reserved for artisanal fishing. Interestingly, the possibility of compensations for fishes illegally caught was not even mentioned in the discussion between the two groups of fishermen (personal observations).

4. Collective Action with Social Regulation

Wealth inequality and the formation of a regulatory authority

In the foregoing discussion, agents have been assumed to interact in a complete decentralized manner. In numerous situations observed in the field, however, there often exists a local authority charged with laying down and enforcing rules for the use of the CPRs (for more details, see Baland and Platteau (1996), chapter 12). The question then immediately arises as to how the cost of collective regulation is borne within the group of users.

Interestingly, in the literature about cooperatives and in that dealing with CPR self-management, the importance of economic and social equality has often been emphasized. Yet, a rejoinder grounded in solid field experiences makes exactly the opposite point that inequality is more conducive to regulated collective action. For instance, in a report issued by the World Bank, we are aptly reminded that "the idea that cooperatives can function only if members have the same background can be refuted by the examples of successful ones in both developed and developing antions" [Braverman *et al*., 1991: 13]. Thus, rural cooperatives in the Netherlands were often created by groups of "influential, better-off farmers who took the initiative to start a services or credit coop and to contribute the bulk of initial share capital. Smaller producers would join at a later stage, contributing smaller shares" [ibidem: 6].

In the CPRs also, there is abundant evidence to show that the costs of initiating and performing regulatory tasks are often borne by the economic elite. Thus for example, in his in-depth study of irrigation systems in South-Indian villages, Wade cogently argued that the effectiveness of a local irrigation council "depends on its councillors all having a substantial private interest in seeing that it works, and that interest is greater the larger a person's landholding" [Wade, 1987:230]. The claims that big landowners can make "are sufficiently large for some of them to be motivated to pay a major share of the organisational costs" [Wade, 1988: 190]. Likewise, in the Pithuwa irrigation system in Nepal, it so happens that many of the large landowners have their lands located near the tail of the system (which is also near to the east-west highway and thus entails low-cost transportation of produce to markets). Even though the area was not organised prior to canal construction, thanks to the initiative of some prominent farmers, the whole irrigation project became self-managed through evolution from organisation on one branch at the tail of the system to the organisation of the entire system [Laitos *et al*., 1986: 126-7 - quoted from Ostrom and Gardner, 1993: 105]. The political role of economic elite in setting up and running a regulatory mechanism can in fact be understood in terms of Olson's analysis: inequality plays a useful role by giving the better-endowed members sufficient incentives to incur the costs involved [see also Bardhan, 1993: 638].

As a matter of fact, the logic of the argument here is the same as that underlying our whole discussion about the potential of collective action with non-convexities. Indeed, in most instances, the creation of a regulatory authority can be interpreted as a public good subject to con-convexities since a large part of the costs involved are in the form of set-up costs. We have so far mentioned the favourable case in which some players are big enough to initiate public action on a voluntary basis. Yet, we know that inequality may weaken the prospect of such action if some users are so small or attach so little weight to their resource endowment that they have no real stake in participating from it. Thus many young people from villages in Botswana work as temporary migrants in South Africa. When they return home (for short periods of time), they do not attend any more the village public forum meetings where issues of common concern including problems of CPR management are debated and settled. The original access rights to village CPRs which they still retain have indeed lost so much of their value that they are not any more induced to participate in collective decision-making [Zufferey, 1986]. In the same vein, as pointed out by Jodha in the case of India, when village elite have attractive outside opportunities, their attitude may be indirectly detrimental to the poor's interests because, as elite, they show indifference to CPR degradation and avoid committing their authority and mobilisation ability to CPR rehabilitation [Jodha, 1992:46-7.

The argument can be further extended to other important aspects of collective regulation, namely, the revelation of correct information, the enforcement of the rules, the incidence of rule abidance, the monitoring of harvesting behaviours, the implementation of sanctions, etc. Indeed, users with a large stake are those who can be expected to truly reveal their own interest in the resource, to see to it that rules are effectively abided by and to show the example in this respect, to spend time and other resources to monitoring and sanctioning activities. Large users may actually find it in their interest to make excess contributions to the regulatory scheme for fear that it would collapse. A vivid illustration of this possibility in the field of industrial economics is the attitude of Saudi Arabia which for many years subsidized OPEC by producing less than its quota of oil to compensate for excess production by other members of the cartel [Heckathorn, 1993: 329].

This being said, it must be stressed that, even when the village elite have large endowments, they may not necessarily use their privileged position to improve the management of local CPRs. There is ample evidence that, on the contrary, they may indulge in greedy behaviours susceptible of bringing them illicit personal advantages at the expense of resource use efficiency. In the laguna of Aby (Côte d'Ivoire), for instance, local elders in charge of the traditional regulation system have been more and more liberal in allowing outsiders to lay their nets (beachseines) in their locality because they can collect substantial underhand dues on their own account [Verdeaux, 1990:203]. In Marovo, Solomon Islands, some young people are dissatisfied with the way elders handle matters of resource management, arguing that they "too readily succumb to the blandishments of the proponents of large scale commercial activities which involve deforestation and soil erosion" [Hviding and Baines, 1994: 29-30]. In the Niger river delta, Mali, the expression 'profiteer water master' has recently gained currency in certain areas where there are mounting tensions about rights of access to inland fisheries [Fay, 1990: 232-3].[4] In Sarawak, Malaysia, forest-dwellers "can no longer rely on their political representatives to defend their interests:" as a matter of fact, "the practice of dealing out logging licences to members of the state legislature to secure their allegiance is so commonplace in Sarawak that it has created a whole class of instant millionnaires." The consequences are catastrophic since "the World Bank has estimated that the country is logging its forest at four times the sustainable rate, while the International Timber Organization predicts that the primary forests of Sarawak will be logged out by the turn of the century" [Colchester, 1994: 79, 82].

These lapses in the elite's behaviour are best understood in the context of a transition between traditional subsistence-oriented economy and an emerging market economy. The sudden realization that common property assets can command a substantial value on the (sales or rental) market prompts unscrupulous customary custodians to treat them as though they were their private property. Insofar as they exceed their traditional prerogatives, they fear that regular illicit transactions (such as underhand rental dealings) will soon be detected and resisted by the common people and this drives them to sell the resource altogether in an irreversible move. The temptation to do so is all the stronger as the sale price of the resource is high enough to open up entirely new economic opportunities for the customary custodians. It must also be pointed out that when the transition period is characterized by a high uncertainty about the nature of

[4] For other illustrations, see Freudenberger and Mathier, 1993:16; Colchester, 1994: 86-7.

future rights of use, the elite is in a privileged position to respond to this uncertainty by unduly appropriating the resource and realize its market value.

Regulation through transfers

We can now turn to the role of inequality when a supra-individual agency can resort to inter-agent transfers to regulate the use of the CPRs. When information is perfect and the central agency is able to enforce inter-agent transfers, the Pareto-optimal situation is attained, and this result holds irrespective of the degree of inequality among the participants. To illustrate, a recent survey of six villages in the Almora district (India) shows that in most of them there exist conservation measures prescribing how fodder is to be extracted from the village forest (e.g., when cutting leaves from trees for fodder, villagers must leave behind at least two-thirds of the leaf cover on the tree) and prohibiting animal grazing for most of the year. In two of the six villages surveyed, the grass in the village forest is sold primarily through auctions. The auction winner is free to cut grass from that section of the community forest for which he has successfully bid during the time period set for that purpose [Agrawal, 1994: 272]. Another illustration of the role of transfers to achieve efficiency is given by Lopez (1984) in his study of fisheries in the Batanes Islands (Philippines): there, the number of boats that go out fishing is determined on the basis of a scout's report of the day's potential catch but the catch is divided equally among all households regardless of the number of boats operated.

Things are much more complex when the assumption of perfect information is dropped. In point of fact, users may have an incentive to lie about their real endowments or their true use of the resource. This is troublesome since knowledge about these is crucial for a central authority to devise a scheme of transfers such that every user is better off at the efficient situation. As Roemer (1988) has shown in the context of a CPR, there is no such scheme that is Pareto-efficient, Pareto-dominates the decentralized equilibrium and can be implemented by the central agency. The implication of this result for our own analysis is that inequality can give rise to a genuine information problem. Indeed, when users are different in non-observable characteristics (e.g., fishing or hunting skills, the value presently attached to the CPR, or the extent of access to outside income opportunities) which directly affect the use of the CPR, it is obviously difficult to assess the distribution of actual access rights in the user population and therefore to design a scheme intended to compensate some users for the loss of these rights. This informational problem is all the more troublesome as it is precisely when access rights are unequally distributed that the role of transfers is important.

As it has been already hinted at, informational problems can help us understand why, when transfers do occur, they seem to often serve to solve allocation problems rather than to compensate users hurt by conservation measures.[5] To recall, monetary compensations are more readily offered by winners when they can draw current and visible gains than when their benefits are hard to ascertain, will take place in an indeterminate future and losers are hard to identify.

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Another serious problem with monetary transfers is that they may run against the ethics of traditional arrangements when they bear upon rights of access to local CPRs. Typically, access to communal resources is mediated through membership in a social group. The relation is in fact reciprocal: on the one hand, group membership is the basis of social rights, and, on the other hand, maintaining access to a share of the corporate productive assets serves to validate membership in the group. In these conditions, it is not surprising that monetary compensations are viewed by community members as a maneuver aimed at buying their exclusion from customary communal rights of access [Berry, 1984; Bourdieu, 1977, 1980].

In fact, evidence from Africa suggests that, when a resource improvement project is implanted in a village, there is a frequent tendency among local inhabitants to exercise pressure so that the project can benefit every one of them. This often leads to tensions between rural development organizations which are keen on completing existing projects (as efficiency would recommend) on the one hand, and, on the other hand, the villagers who are anxious that the benefits are evenly spread among all of them and therefore frequently ask that new projects are being started in other parts of the village before the first are completed. This kind of experiences attest to the low acceptability of compensatory transfer payments when some agents are excluded from the benefits of a localized public good [see, for instance, Laurent and Mathieu, 1995, 91].

Regulation through exclusion

When transfers are not possible, Kanbur (1992) has contended that the Pareto-optimal situation is all the more difficult to reach as the user group is more heterogeneous. Since the example constructed by Kanbur is faulty,[6] we present an alternative formulation of the problem from which it comes out that at the efficient level of resource use the 'small' users (those with a lower level of exploitation of the CPR in the unregulated situation) may be worse off than in the decentralized, inefficient equilibrium.[7] Consider two individuals, indexed 1 and 2, choosing harvesting efforts y1 and y2, that yield payoffs R1 and R2 as given below:

(1)

(2)

The payoff functions embody a negative externality: each individual's action affects the payoffs of the other individual adversely. One way to interpret the above equations is to construe the first term as private net benefits and the second term as a common social cost that depends on the joint exploitation of a given natural resource. The equations also contain an asymmetry in the parameters a1 and a2 to indicate that the marginal value of the action differs between the two individuals. One possible interpretation is that they reflect unequal skill endowments: the higher the value of a1, the more skills user i displays in extracting income out of the resource. Alternatively, the second term of the

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equations may be interpreted as the reduction in the future value of the CPR while the first term is thought of as the current net income: the higher a1, the more impatient user i is to appropriate incomes from the resource. The Nash equilibrium values, superscripted by N, are thus:

(3)

(4)

By contrast, the efficient solution requires that (R1 + R2) is maximised. With the above parameter values, it turns out that y2 must be equal to zero (y2C=O): in other words, efficiency would require user 2 to be deprived of access to the resource. In that case, the efficient solution is obtained by maximizing R1 alone. Setting boy y2 and R2 to zero, we then get: y1C=2/3, and R1C=2/3. A comparison of these two sets of results shows that individual 1 gains from regulation and that the total level of resource exploitation decreases. This outcome obtains because the comparative inefficiency of user 2 is so high (at the Nash equilibrium, the net income of user 2 compared to that of user 1 is only 11% while his comparative level of resource use is 1/3) that joint unregulated exploitation of the resource imposes considerable sacrifices on the more efficient user. Conversely, the efficient outcome requires that the other user endures unacceptable sacrifices for which he cannot be compensated. Interestingly, it is precisely because some agents cannot have their minimax payoffs that the efficient outcome cannot be sustained as a sub-game perfect Nash equilibrium of the infinitely repeated version of the game (this is a direct application of the Fold theorem).

If disparity between users is less, the room for conflict regarding regulation is considerably narrowed down. For instance, if all users are identical, they will all benefit from regulation. Or, if a1=2, and a2=1.5,y1N=p.54,y2N=0.38, R1N=0.36, R2N=p.p35, while y1C=0.40, y2C=0.20, r2C=0.46 and R2C=0.09. In the latter case, therefore, both users increase their payoffs by moving from the Nash to the regulated equilibrium. Clearly, the more inequality, the more the efficient solution (without transfer) will hurt a fraction of the users. If we require that the regulated solution Pareto-dominates the unregulated one, a higher degree of inequality thus implies more inefficiency.

The foregoing example also points up an important solution to the problem of CPR degradation in the form of the exclusion of some users. It is noteworthy that this result is by no means a special case associated with the specific functional forms used above. Exclusion is moreover a possibility even then there is little inequality because an excessive population of users may require that a number of them be deprived of access to the resource in order to avoid its overexploitation or mismanagement.

The problem with exclusion is of course that in the absence of transfers, it involves considerable costs in terms of distributive justice. If the decision is made as the result of a voting procedure in which all users equally participate, there is a good presumption that a majority voting will favour the *statu quo*. This presumption is all the stronger when CPR users are risk-averse and are *a priori* uncertain about who will be eventually excluded [see, in particular, Steinherr and Thisse, 1979; Fernandez and Rodrick, 1991].

In many cases, however, the exclusion procedure is not random, but is directed against minority groups which are easily identifiable. Especially vulnerable are outsiders or immigrants of recent origin, who usually have low or precarious entitlements. For instance, at the end of the 15th century, as a result of rising pressure on the Alpine ecosystem the inhabitants of Törbel village signed a convention establishing an association to achieve collective regulation over the use of the alp, the forests and the waste lands. One important feature of this convention is that access to the latter was strictly limited to local citizens [Netting, 1981]. In Indonesia, following overexploitation of inshore waters and the resulting serious conflicts, President Soeharto decided to establish a protected zone exclusively reserved for fishermen operating small-scale artisanal boats who all happen to be of Indonesian origin: this measure was actually aimed at excluding from this zone trawler boats which were all owned by Chinese families. Such a decision appeared to Soeharto as a providential strategic weapon to use with a view to gaining political capital on the eve of the 1982 elections. Soeharto was particularly vulnerable to popular resentment against Chinese economic dominance as zealot Muslims resented the fact that he did not declare Indonesia as an Islamic state, and he himself was well connected with Chinese financial interests [Mathew, 1990--for other examples, see Noronha, 1985; Watts, 1993; Laurent *et al*, 1994]. In Europe, the Enclosure Movement in pre-industrial England is probably the best documented illustration of an exclusionary move by politically and economically dominant groups [Allen, 1992; Cohen and Weitzman, 1975]. In over-populated areas of Sub-Saharan Africa, there is increasing evidence that members of young age classes are liable to be deprived of access to scarce natural resources due to their low position in the social and political structure of village societies. As the experience of Rwanda shows, this kind of exclusionary process creates major tensions in rural societies that may easily degenerate into open and even armed confrontations [Laurent and Mathieu, 1995, 194-5; Andre and Platteau, 1996].

Regulation through quotas

What happens if regulation takes on the form of a uniform quota imposed on all users? Such a solution may be appealing because of its inherent simplicity. Consider again the example used in the last section. When a1=2 and a2=1, we find that at the regulated equilibrium the uniform quota maximizing the sum of the two individual payoffs is equal to 0.27. The corresponding payoffs are, respectively, 0.32 and 0.09. Contrary to what obtained under the efficient solution, here the most efficient user is worse off and the less efficient user is better off than under the Nash equilibrium situation (and, a fortiori, under the efficient solution). This result also holds when a1=2, and a2=1.5 (the uniform quota is equal to 0.30, and the payoffs are respectively 0.33 and 0.20), yet there is some minimum level of disparity in resource use efficiency below which it ceases to be true, and the solution provided by a uniform quota Pareto-dominates the Nash equilibrium.

In the light of the above, it is easy to understand the following statement made by Johnson and Libecap (1982) when analyzing the failure of cooperative mechanisms for catch restriction in the over-capitalized shrimp fishery of Texas: "Contracting costs are high among heterogeneous fishermen, who vary principally with regard to fishing skill. The differential yields that result from heterogeneity affect the willingness to organize with others for specific regulations…regulations that pose disproportionate constraints on certain classes of fishermen will be opposed by those adversely affected. (…) Indeed, if fishermen had equal abilities and yields, the net gains from effort controls would be evenly spread, and given the large estimates of rent dissipation in many fisheries, rules governing effort or catch would be quickly adopted. (…) For example, total effort could be restricted through uniform quotas for eligible fishermen. But if fishermen are heterogeneous, uniform quotas will be costly to assign and enforce because of opposition from more productive fishermen. Without side payments (which are difficult to administer), uniform quotas leave more productive fishermen worse off" [Johnson and Libecap, 1982: 1006, 1010].

The socio-anthropological literature actually abounds with examples in which equal access (and thereby a uniform quota) to local-level CPRs is granted to all the village members and the system is strictly enforced. There are four different ways of accounting for this widespread phenomenon. First, egalitarian access may be the only possible outcome in usually unregulated situations where the harvesting technology is so simple that every houselhold has more or less the same ability to reap the CPR produce (e.g., in fuelwood collection, trap-fishing or gathering of grass for fodder). Second, a uniform quota may be the only feasible solution available to regulate the commons (particularly due to information and enforcement costs) and, as we have seen above, it may Pareto-dominate the unregulated outcome provided that inequality is not too large. Third, since access to communal properties serves to validate membership in a community (see supra), any inequality in the distribution of access rights would be perceived as reflecting an hierarchy in social status and would therefore be considered illegitimate. Fourth, in inegalitarian agrarian societies, the economic elite may behave as patrons concerned with the subsistence of poor people. As a matter of fact, egalitarian access to local CPRs has often constituted an important component of the informal insurance mechanisms whereby the deprived sections of rural communities have been socially protected. As a result, inequality at the global (village) level may well be associated with a rather equal distribution of local CPRs.[8]

Situations where economic differentiation is combined with a relatively egalitarian treatment of all villagers with respect to use of local CPRs have been clearly pointed out by McKean in the case of Japan. In Japanese villages, indeed, inequality in private landholdings and political power went hand in hand with equal (family) access to CPRs.[9] In her own words, "Japanese villagers were deeply concerned with some notion of fairness. (…) Fairness was not synonymous with equality in material possessions. (…) But there was an overriding sense that access to the commons should be distributed according to some principle of fairness that ignored existing maldistributions in private

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wealth. Hence the frequent use of random distributions, assignment to parcels or products of the commons by lottery, frequent rotations to move the good and the bad around, and scrupulous attention to bookkeeping to keep track of contributions and exchanges and offsetting aid offered by one household to another. (…) Nor did this notion of fairness mean that entitlement was automatic for all comers; (…) a household had to earn its eligibility through some period of established residence in the village, and casual drifters were ignored" [McKean, 12986: 568-9]. The adoption of these measures actually occurred during the 17th century as a response to increased environmental pressure on common lands which caused serious degradation of village forests: "visible deforestation seems to have made villagers aware of the very real risks of overuse and enabled them to develop and enforce stricter rules for conservation on their own initiative to save their forests and commons from the same fate. Rather than destroying the commons, deforestation resulted in increased institutionalization of village rights to common land. And it promoted the development of literally thousands of highly codified sets of regulation for the conservation of forests and use of all commons" [McKean, 1986:549--for similar systems in India and Nepal, see Guha, 1985: 1940; Arnold and Campbell, 1986:436].

We can find similar examples in Europe. Thus, management of common woodlands in southern Belgium often implies a strictly egalitarian access, each family being entitled to a specified amount of fuelwood per year, a right locally known as 'affouage'. The trees to be cut are designated by the communal authority.

Interestingly, when equal access to local CPRs is not sufficient to guarantee the subsistence of the poor due to exceptional circumstances, the rich, behaving as patrons, tolerate rule violations by the poor. This typically occurs in the villages studied by McKean: under stress conditions, tolerance arose vis-à-vis poor resource users and "inspectors or other witnesses who saw violations maintained silence out of sympathy for the violators' desperation" [McKean, 1986: 566]. A similar observation has been made by Wade in his study of South-Indian villages: when crisis conditions created by drought cause desperation among the poor members of the local communities, they follow "short-term strategies which they would not contemplate in normal times" and break the rules laid down for effective management of water in irrigation schemes [Wade, 1988: 204]. This attitude of tolerance on the part of the rich can be re-interpreted in terms of the PD-CG encounter framework described earlier: the PD players feature the poor members who heavily discount the future and the CG players feature the rich members who can afford to pay more attention to the long-term sustainability of the CPR. The latter are willing to abide by the conservation rules as long as they are sufficiently numerous.

5. Conclusion

There is a tendency nowadays in the literature to represent issues of collective action as though agents were acting in a completely decentralized way. This research programme is obviously influenced by the rapid development of non-cooperative game theory as a powerful tool to analyze strategic human interactions. Now, there is an apparent discrepancy between this approach and one of the main conclusions which emerge from the large body of empirical literature dealing with local-level management of common property resources. This literature is indeed replete with examples where natural resources at village level are managed on the basis of rules designed and enforced by a regulatory agency.

Without denying the importance of distinguishing between the two kinds of situations (as has been actually done in this paper), it must be reckoned that even when dealing with regulated settings, at some point in the analysis, one cannot evade the question as to how agents acting in a non-coordinated way initiate and enforce the regulation scheme. It is thus not surprising that the basic argument underlying our whole discussion about the potential of collective action in a decentralized setting also applies when the creation of regulatory mechanisms is considered. In this argument, the distribution of incentives among agents plays a crucial role. As a matter of fact, a disequalizing change in the distribution of access rights has two effects which run in opposite directions. The agents who benefit from such a change have a larger stake in the common property resource and therefore have a greater incentive to take conservation measures. Simultaneously, the same change has a corresponding disincentive effect on the other agents whose endowments have been reduced. Increasing inequality, because it redistributes incentives in different directions, thus has ambiguous effect on the ability of users to take steps towards conserving their resources and even towards setting up the required mechanisms.

Moreover, inequality raises particular problems for regulation of resource exploitation. Indeed, given the well-documented limitations on the regulatory instruments available, the sharing of costs and sacrifices required by (second-best) efficiency may prove unacceptable to some users. Under these circumstances, an homogeneous group may better succeed in designing and enforcing conservation measures than a heterogeneous one.

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