# Chapter 18

# Economics of Common Property Management Regimes

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**Jean-Marie Baland and Jean-Philippe Platteau[1]**

**Centre de Recherche en Economie du Développement (CRED)**

**Department of Economics**

**Faculty of Economics, Business, and Social Sciences**

**University of Namur, Belgium**

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## Part 1 : Introduction

### 18.1.1 Motivation and outline of the paper

During the last decades we have witnessed an impressing upsurge of empirical literature dealing with common-property resources. Responsible for most of these writings are social scientists of different brands, particularly, sociologists, anthropologists, geographers, human ecologists, and political scientists. So far, the contribution of economists to the accumulation of empirical knowledge about such resources has been rather modest unlike their theoretical efforts which have conspicuously multiplied during the same period. The available empirical literature is quite disparate in the sense that it relies on different sorts of evidence and methods of investigation. There are in-depth case studies of one or two resource or village-level management systems –as illustrated by the works of Ensminger (1992) on Orma pastoralists (Kenya), and of Alexander (1982) on Sri Lankan beach seine fisheries ; comparative, essentially qualitative assessments of various field situations located in a rather restricted area –as exemplified by the works of Wade (1988 a and b) on irrigation and grazing resources in a southern Indian state, and of Peters (1994) on grazing resources in Botswana; cross-section quantitative analyses of resource management systems belonging to different environments –see, e.g., the works of Tang (1991, 1992), Lam (1998), Bardhan (2000) and Fujita et al. (1999) on irrigation systems, or that of Gaspart and Platteau (2001) on fishermen's regulatory schemes in Senegal; and broad-sweeping overviews of observations made in different regions and countries, possibly involving different types of resources, –such as the works of Singh (1994) and Sengupta (1991) on India and the Philippines.

A striking feature of most of these studies lies in the fact that their authors are generally convinced that, given the glaring failure of state ownership experiences in developing countries, collective, community-based regulation holds out the best prospects for an efficient management of village-level natural resources. Yet, since they recognise at the same time that the balance sheet of actual experiences of common property management is mixed, the central aim of their inquiries is typically to understand the reasons that can account for these varying levels of performance of user-managed resource systems. Moreover, such mixed record prompts many of them to believe that a realistic solution to the problem of village resource conservation will necessarily entail a certain level of co-management between direct users, on the one hand, and state authorities or specialized agencies, on the other hand.

The purpose of the following analysis is to identify the reasons for collective action failures and successes in natural resource management as they emerge, whether explicitly or implicitly, from the burgeoning literature of the last decades. It is also to try, in the light of economic theory, to have the best analytical understanding of the mode of operation of the factors involved whenever this is possible. Our analysis is presented in four successive parts. In Part 1, of which this introductory remarks form a part, we clarify the notion of common property management regime, provide cautionary remarks about estimation methodologies commonly used (a point that is elaborated further in the Appendix), and analyze two set of polar circumstances, one under which common property regulation is very unlikely to succeed, and another where it is the only solution available. In Part 2, we focus on the general case where common property regulation is feasible yet only if governance costs are kept to a reasonable level. Here, emphasis is shifted to factors on which recent theoretical endeavours can shed a new light, namely the size of the user group, income or wealth inequality, and availability of exit opportunities. The role of these factors is assessed within the framework of three theoretical models corresponding to different characteristics of the common property situation contemplated. Special attention is paid to the aspect of inequality since this has remained a rather confused issue in much of the empirical literature and economic theory can contribute significantly to improving our understanding of the manner it bears upon collective action. In Part 3, we discuss two important impediments to the design and implementation of efficient common property management systems. Cognitive problems and state actions are analyzed successively under this heading. In Part 4, before we summarize our main points, the importance of appropriate incentive systems under a co-management approach to village-level resources is underlined and illustrated.

### 18.1.2 Common property management regime

Before embarking upon this agenda, it is necessary to precise what we mean by a common property management regime. A common property management regime implies that various restrictions are imposed on members of a well-defined group of people regarding the manner in which they may use local-level resources. In other words, common property management implies collective regulations regarding both membership and the way to use the resource, and the existence of monitoring and sanctioning procedures so that those rules can be effectively enforced. Here below, we offer three detailed illustrations of what collective regulation can mean in the specific context of three different natural resources : regulation of village forestry and pastures in Tokugawa rural Japan, regulation of villages pastures in Rajasthan (India), and regulation of access to the sea in coastal communities of Southern Sri Lanka.

BOX 1: Management of village commons in Japan (1600-1867)

McKean (1986) collected materials on three Japanese villages –Hirano, Nagaike, and Yamanaka– with a view to assessing the way local commons were regulated on a micro-basis during the Tokugawa period (1600-1867). At that time in Japan, about half of the surface of forests and uncultivated mountain meadows were held and managed in common by rural villages, the other half being under imperial or private property.

Japanese villages actually succeeded in developing 'management techniques to protect their common lands for centuries without experiencing the tragedy of the commons' (McKean, 1986: 534). They used extremely detailed rules of access and conservation procedures. For example, in order to prevent the *kaya* –a grass grown to produce thatch for roofs –from being cut at an immature stage for horse fodder, villagers usually designated an area with *kaya* as 'closed' during the growing season. On the other hand, to ensure that daily cutting of fresh fodder for draught animals and pack-horses did not deplete the supply available for winter, villagers in Hirano designated one open area for daily cutting of fresh grass and another closed area as a source of grass to be dried into fodder for the winter (McKean, 1986: 553-4).

Village forests were essentially divided into two zones: open patches of forest and closed reserves. Villagers could enter the first zone at any time 'as long as they obeyed rules about taking fallen wood first, cutting only certain kinds of trees and then only those that were smaller than a certain diameter, and only with cutting tools of limited strength (to guarantee that no tree of really substantial size could be cut)': or 'about leaving so much height on a cut plant so that it could regenerate, or taking only a certain portion of a cluster of similar plants to make sure the parent plant could propagate itself, or collecting a certain species only after flowering and fruiting, and so on'. Also, to limit the quantity of plants collected, village authorities could prescribe the size of the sack or container used for that purpose. To control access to the first zone in a tighter way, the same authorities could also issue entry permits 'carved on a little wooden ticket and marked "entrance permit for one person" ' (McKean, 1986: 554-5).

As for the closed reserves, they were set aside 'for items that had to be left undisturbed until maturity and harvested all at once at just the right time, or that the commons supplied in only adequate, not abundant, amounts'. The time for collection and the rules to be followed by each collector were decided by the village headman. For example, if the supply of a given natural product was limited, 'the reserve might be declared open for a brief period (two or three days) and households allowed to send in only one able-bodied adult to collect only what could be cut in that time'. Precise rules for harvesting varied from product to product and from village to village, yet, as a matter of principle, they 'appeared to be a judicious combination that rewarded strength and hard work but also severely limited the circumstances in which cutting was allowed, which ensured that the total supply was not threatened and no extreme inequality appeared among households in a given year or among *kumi* (groups of households) over time' (McKean, 1986:555-6). The latter requirement could drive the local authorities to devise fixed rotational sequences so that each household or groups of households had access to patches of varying quality.

It is important to note that there were written rules about the obligation of each household to contribute a share to collective work intended for maintaining the commons, such as systematic programmes for harvesting and weeding of certain plants in a particular sequence to increase the natural production of the plants they wanted; or the burning of the common meadow lands which was conducted each year to burn off hard and woody grasses and thorny plants (and kill pests), and which involved 'cutting nine-foot firebreaks ahead of time, carefully monitoring the blaze, and occasional fire-fighting when the flames jumped the firebreak' (Mc Kean, 1986; 558-9).

Apparently, Japanese villages widely resorted to selective inducements and punishments in order to ensure due respect of the written codes which most of them had to govern their CPRs. Regarding inducements, we are thus told that "there was an intrinsic pride in the importance of doing one's duty by the commons and in preserving the village's well-being ; a young man brought credit to his family and future by doing the job properly …" [McKean, 1986: 564]. Regarding punishments, the evidence is that "violating rules that protected the commons was viewed as one of the most terrible offences a villager could commit against his peers, and the penalties were very serious" [ibidem: 561]. In order to detect rule infractions, purposeful monitoring was practised in the form of groups of detectives destined to constantly patrolling the commons: "the detectives would patrol the commons on horseback every day looking for intruders, in effect enforcing exclusionary rules". Their job was considered "one of the most prestigious and responsible available to a young man" [ibidem: 560-1]. According to villages, these positions changed hands more or less frequently and, in some of them, all eligible males had to take a turn, so that no family was without its full labour supply for very long. In the poorest villages, specialised but rotating detectives did not exist (probably because people were too poor to spare the required labour), yet anyone could report violations [ibidem: 561].

When necessary, Japanese villages did not hesitate to threaten to use their more powerful sanctions: "ostracism in increasingly severe stages, followed by banishment". Ostracism - which implies that the village community "cuts off all contact with the offender except for assistance at funerals and fire-fighting" - was thus resorted to in gradual stages, "starting with social contact and only escalating to economic relations if the offender did not express remorse and modify his behavior". Moreover, "to ensure that the villagers would remember to shun contact with someone subjected to ostracism, that person might be expected to wear distinctive clothing (a flashy red belt or pair of unmatched socks)" [ibidem: 562].

<u>BOX 2 : Management of village pastures in Rajasthan (India)</u>

In the arid areas of Western Rajasthan, before the modern state was formed by conglomerating the princely states of Rajputana, communal grazing lands used to be under the effective control of big landlords known as *jagirdars* who took upon themselves the task of deciding and implementing "conservation measures which ensured considerable stability to these resources" [Shanmugaratnam, 1996, p. 172]. Thus they charged grazing taxes, organised rotational grazing around (evenly scattered) water-points, decreed the periodical closure of parts of the commons and periodical restrictions on entry of certain animal species, appointed watchmen to monitor compliance with the grazing regulations, imposed penalties on herd owners found guilty of violating them, and used their authority to extract regular labour contributions for maintenance works from poorer users. Such measures had the effect of conserving perennial grass species and trees and of allowing effective rotational grazing thanks to proper maintenance of water points [Jodha, 1987, 1989].

Box 3 : Regulating access to the sea in a coastal fishing community

The sea tenure system discovered by Alexander (1980, 1982) and by Amarasinghe (1989) in the beachseine fishing communities of southern Sri Lanka involves the rotational assignment of fishing spots in such a manner that all fishermen get equal access not only to fish but also to fish in the best spots.

Beachseining is a fishing technique that requires a rather large water space (since it is intended for catching a whole school of fish) located close to the shore and with a smooth sea bottom. Furthermore, the laying of a beachseine and its subsequent hauling takes only a few hours so that, on a particular day, only a maximum of 4 nets can be operated on each suitable location. Moreover, incomes from beachseining are significantly affected by the timing of fishing operations, within a daytime as well as across seasons.

From Alexander's account (1980: 97-102; 1982: chapter 7), the collective management scheme is defined by the following rules:

(1) Membership in the village community, whether hereditary or acquired in a lifetime, involves a right of access to the community-controlled sea area (local fishermen belong to the same kinship group).

(2) Ownership of a net carries the obligation to work it when required.

(3) There is no labour market and, since a beachseine normally requires eight fishermen to operate, joint ownership of nets is the rule and the usual ownership share in a net is 1/8. In fact, each net is divided into eight sections or shares but "once the net is in operation individuals have no particular rights to the sections they have contributed" (Alexander, 1982: 142).

(4) Net shares, and the accompanying access right to the sea, can be transferred only through inheritance (ibidem: 203).

Equal access is guaranteed through a turnover system that determines turns in a sequence of net-hauling rights. Thus, in the village studied by Alexander, the fishing area is divided into two stations: the harbour side (from which most big catches come) and the rock side. The net cycle begins on the harbour side and, after a net has had the dawn turn on that side, it is entitled to the dawn turn on the rock side on the next day. Subsequently, it may be used on the rock side each day once the net immediately following it in the sequence has been used. The sequence of net use over a period of five days, where each of the eight existing nets is denoted by its number, is shown in the following table (Adapted from Alexander, 1982: p. 145).

| | Fishing Station | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Harbour | | | | Rock | | | |
| Day | Dawn | | | Night | Dawn | | | Night |
| One | 5 | 6 | 7 | 8 | 4 | 3 | 2 | 1 |
| Two | 6 | 7 | 8 | 9 | 5 | 4 | 3 | 2 |
| Three | 7 | 8 | 9 | 10 | 6 | 5 | 4 | 3 |
| Four | 8 | 9 | 10 | 11 | 7 | 6 | 5 | 4 |
| Five | 9 | 10 | 11 | 12 | 8 | 7 | 6 | 5 |

Over the full net cycle, each net is thus operated eight times.

### 18.1.3 Methodological considerations

At this stage, we must make an important methodological caveat. Indeed, identifying the factors underlying variations in performance levels for common property management is a much more arduous task than may appear at first sight. A major difficulty lies in the fact that the estimation procedure usually applied in cross-section studies based on large samples of user groups aimed at such identification is fraught with serious endogeneity effects that compound the classical problems raised by this type of methodology.[2] In actual fact, many studies overlook the endogeneity relationships between the organisational form, the expected gains, and the user characteristics. Thus, when concluding that small and homogeneous groups are better conducive to collective action than groups with opposite characteristics, authors tend to forget that group size and composition may themselves be the product of a decision made by users in the light of their specific environmental conditions (see the Appendix for a detailed exposition of this point).

To highlight the reasons behind successes and failures of collective action in village-level resource management, in-depth case studies of particular user communities and resource systems are therefore extremely useful as a complement to cross-section statistical analyses. They allow researchers to have a solid understanding of the details of the common property management mechanism and to use individual users or households as observation units. Moreover, such data can be subject to quantitative analysis in order to identify the determinants of individual participation to the collective mechanism (see White and Runge, 1995; Gaspart et al., 1998). From there, it should be possible to shed light on important questions, such as whether participation is more intense and more widespread among rich than among poor users, among village leaders than among common people, etc. In addition, by reconstructing chains of past events, it is possible to uncover dynamic processes at work in the user group and the village society as a whole, in particular the processes of group formation and rule setting. Distinguishing user characteristics that are exogenous from those that are endogenous and understanding how the processes of endogeneisation take place then

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[2] Panel data are less subject to the aforementioned problem. Unfortunately, they are not yet available for the type of enquiry considered here.

become a feasible task. Finally, careful recording of the characteristics of the user community, the resource system, the harvesting technology, and the role of state agencies as well as a detailed assessment of the initial conditions and the outcomes of endogenous processes, should allow one to draw useful lessons about community- and village-level characteristics conducive to effective common property management. This however necessitates that a comparative analysis can be carried out on the basis of the available case studies.

It must be emphasised that, to be really insighful, especially in a comparative analytical perspective, it is important that in-depth case studies are guided by well-defined research questions and grounded in solid theory whenever it exists. Unfortunately, this requirement is too rarely met in reality, perhaps because many village studies are still inspired by a holistic approach that lays stress on the opposite need to avoid precise questions and hypotheses considered as so many blinkers prone to biase observations and results.

### 18.1.4 Two polar cases: collective regulation is doomed or indispensable

#### 18.1.4.1 The rationales of resource division

As we know from standard economic theory, the problem with resources under open access or under community ownership limited to membership rules –what Baland and Platteau (1996) call ‘unregulated common property’– is the fact that externalities are not properly internalised. If there were no transaction costs, ‘regulated common property’ (i.e., collective ownership with both membership rules and rules of use) would be equivalent to private (and state) ownership. Yet, the presence of pervasive transaction costs in real world situations tilts the balance in favour of private ownership: as a matter of fact, being under the control of a single person, private ownership avoids all kinds of negotiation costs necessary to reach a collective agreement as well as all the governance costs that have to be incurred with a view to monitoring and enforcing such agreements. There is no escape from the fact that regulation often remains imperfect as it is difficult to eliminate all the inefficiencies arising from a collective mode of exploitation. The remaining inefficiencies must therefore be considered as genuine costs of maintaining the commons. In other words, regulation is necessarily imperfect and a fully efficient outcome cannot be expected to result from the joint exploitation of a natural resource.

On the other side of the balance sheet, there are several advantages of (regulated) common property that may possibly compensate for the above shortcoming of imperfect internalisation of externalities. The first advantage lies in scale economies. These exist almost always on the side of costs, if the alternative is to divide the resource into several private portions that have to be enclosed and protected. Indeed, the costs of negotiating, defining and enforcing private property rights are increasing with the physical base of the resource: the more spread the resource base (or the less concentrated the resource) the higher the costs of delimiting and defending the resource 'territory'[3]. Scale economies may also exist on the side of benefits, being present either in the resource itself or in complementary factors. Resources offering multiple products because they form part of an overall ecosystem are a good example of the former kind of situation (think of forests or mangrove areas). On the other hand, the obvious advantage of co-ordinating the herding of animals so as to economise on shephard labour in extensive grazing activities is probably the best illustration of the way scale economies in a complementary factor may prevent the division of a resource domain (see, e.g., Dahlman, 1980; Netting, 1981; Binswanger et al., 1989; Bromley, 1989: 16; Nugent and Sanchez, 1993).

Risk-pooling considerations constitute another important and well-known advantage of common property. When a resource has a low predictability (that is, when the variance in its value per unit of time per unit area is high), the need to insure against the variability of its returns across time and space militate against resource division (McCloskey, 1976; Dahlman, 1980; Runge, 1986; Dasgupta, 1993: 288-89; Nugent and Sanchez, 1993: 107; Singleton, 1999)[4]. Indeed, users are generally reluctant to divide it into smaller portions because they

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[3] Note that the indivisibility of natural resources needs not always arise from their spatial spreading. Thus, for example, a water source is extremely difficult to apportion to several users even though it is a highly concentrated resource.

[4] High yield variance is also one of the five conditions favourable to common property listed by Netting (1976). The four other conditions are a low value of resource productivity (see supra), few possibilities of

would thereby lose the risk-pooling benefits provided by the resource kept whole. Such loss is especially noticeable in the case of extensive herding and fishing (whether in inland or marine fisheries). Indeed, herders (fishermen) may need to have access to a wide portfolio of pasture lands (fishing spots) insofar as, at any given time, wide spatial variations in yields result from climatic or other environmental factors. Note carefully that, to be valid, the risk-pooling argument presupposes the existence of positive enforcement costs of private property, otherwise scattered privately-owned parcels could well provide the required insurance to resource users (see however Baland and Francois, 2001).

18.1.4.2 Where resource division is inevitable

There are thus arguments *pro* and *contra* the division of a resource and the issue cannot be settled on a priori grounds but only in a contextual manner (Baland and Platteau 1998b; Platteau, 2000: Chap. 3). This said, polar situations arise where the choice is evident. One such situation occurs when the profitability of resource division and privatisation is so high that this option is incontrovertible. This is likely to happen when there are no scale economies (on the side of benefits) nor risk-sharing advantages in keeping the resource domain whole. However low are the inefficiency losses resulting from common property, the corresponding costs are still too high compared with the savings that can be realised on enforcement costs.

The most relevant case here is that which arises when the value of a resource is high owing to population growth and/or market integration and delimitation or enforcement costs of private property are moderate. In such circumstances, indeed, even a rather effective system of collective regulation can easily result in comparatively large amounts of rents foregone by not dividing the resource. Hence the frequent emphasis in the literature on the unit value of natural resources as one of the main determinants of its privatisation (division) (Dyson-Hudson and Smith, 1978; Cashdan, 1983; Levine, 1984; Wade, 1988a: 215; Libecap, 1989: 21; Dasgupta, 1993: 288-89; Noronha, 1997: 49; Baland and Platteau, 1999; Singleton, 1999;

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intensification, a large area needed for effective use (see supra), and a large labour- and capital-investing group [Netting, 1976: 144].

Platteau, 2000: Chap. 3). For example, in his classical study of the Swiss Alps, Netting contrasts the lowlands of the valley which are fertile and therefore tend to be privately appropriated with the more arid highlands which are used as communal (summer) pastures under the authority of the village council (Netting, 1972, 1976, 1981, 1982). Generally, when a resource requires substantial investments and regular maintenance to be conserved and improved while the option of privatisation is available (enforcement costs of private property are not too high), that option generally proves to be irresistible and attempts to keep the resource under common property are bound to fail despite the best intentions and efforts of users or community organisers. The natural transformation of the ownership system over agricultural lands in areas subject to rapid population growth and agricultural intensification offers a vivid illustration of this principle (see Boserup, 1965: 79-81).

#### 18.1.4.3 Where resource division is prohibitively costly: the evolutionary view

Another polar case arises when, unlike in the above kind of situations, the option of private ownership is not available because enforcement of private property rights is prohibitively costly or indivisibilities are pervasive. One can think of resources that are highly mobile over large expanses of territory (open-sea fishing and hunting, in particular), or of those, such as irrigation water, which require a collective infrastructure to be exploited. In these peculiar circumstances, collective regulation under the common property regime is the only way to avoid the inefficient management and/or the degradation of the resource under conditions of open access.

The question is then how can one be assured that the required mode of resource governance will be established and maintained ? It is at this juncture that the evolutionary doctrine must be brought into the picture since it stresses the considerable ability of rural communities to adapt to changing circumstances. In conformity with the induced institutional innovation hypothesis (Kikuchi and Hayami, 1980 ; Hayami and Ruttan, 1985 ; Binswanger and McIntire, 1987), its proponents argue that collective regulation of a resource may evolve under (moderate) population growth when its privatisation remains prohibitively costly.

Thus, Hayami and Kikuchi point out that, under these conditions, "the social structure becomes tighter and more cohesive in response to a greater need to co-ordinate and control the use of resources as they become increasingly more scarce". As scarcity increases and competition is intensified, rules are defined more clearly and enforced more rigorously, whether they serve to define rights and obligations among people on the use of the resource or to settle possible conflicts. Inasmuch as the environment determines which resources are scarce, which are difficult to privatise and which are relatively easy to handle at village level, environmental conditions are "a critical variable in the formation of village structure" (Hayami and Kikuchi, 1981: 21-22; Hayami, 1997: 92)[5].

Close to Hayami and Kikuchi is the position taken by Wade on the basis of detailed village studies in South India (1988A). According to him, indeed, "villagers will deliberately concert their actions only to achieve intensely felt needs which could not be met by individual responses", that is, "they will straightforwardly come together to follow corporate arrangements" whenever "the net material benefits provided to all or most cultivators are high" (Wade, 1988a: 185-88, 211). Wade is actually confident that when no other, more decentralised alternative is available, villagers will somehow succeed in overcoming the incentive problems associated with collective action. Lawry reaches a similar conclusion: "collective action is more likely to result where the common resource is critical to local incomes and is scarce", and where privatisation appears unfeasible or too costly (Lawry,

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[5] As an example, Hayami and Kikuchi mention the differential evolution of rural social organisations (as measured by the tightness in community structure) in Thaïland's Central Plain, on the one hand, and in Japan and the mountainous areas of the Philippines (such as in the Ilocos region), on the other hand. In their account, the role of population density and topography (mountainous terrain is more congenial to local-level infrastructure) is quite predominant: while in the major part of Thaïland's Central Plain, rice farming depends on the annual flooding of a major river delta, which is beyond the control of peasants either individually or in local cooperative groups, in Japan (and the Ilocos region of the Philippines) it initially developed in fan-shaped terraces in the valley bottoms and intermountain basins, a topography which makes local cooperation effective in controlling a water supply based on small streams (Hayami and Kikuchi, 1981: 22-23)[5]. Note that, when public goods such as irrigation infrastructure require a spatial basis exceeding the rather confined limits of a village community, state intervention is called for. A complete, but daring, induced institutional innovation theory would argue that the right kind of state would emerge in such circumstances to solve the public good problem that conditions people's survival (see Wittfogel, 1957; Hunt, 1989; Allen, 1997, for attempts in that direction). For a critique of the latter, see Weiss and Hobson, 1995: 85-7.

1989b: 7-9). Boserup herself did not think differently: "when grazing opportunities become scarce, rules are likely to be laid down concerning the number of animals a cultivator family is allowed to have and the amount of straw the cultivator is allowed to remove with the harvest." (Boserup, 1965: 85). Such a view, it must be noted, is shared by those political scientists for whom leadership and rules arise within social groups in response to the need to regulate the allocation of resources under conditions of scarcity (see, e.g., Tyler, 1990: 66-67).

18.1.4.4 Where resource division is prohibitively costly: the unregulated common property

The evolutionary view sounds too optimistic, however. Collective management is not the only possible outcome in the presence of prohibitively high privatization costs and the value of the resource justifies its regulation. Indeed, one cannot exclude the possibility that the resource is going to be overexploited and depleted under na open access or an unregulated common property regime. Under open access, there are no rules guiding access to the resource, nor rules governing its use. In such circumstances, the Tragedy of the Commons occurs: productive inputs are wastefully used and the scarcity rents associated with the resource are totally dissipated (Hardin (1968)).

Under unregulated common property, membership of user groups is fixed, yet there are no rules regarding the use of the resource that rightsholders are supposed to follow. The absence of rules of use may be due to various reasons: external factors, such as the low value (or the abundance) of the common property resource, or adverse state policies and actions that have the effect of emasculating community-based organizations, and internal factors, by which we mean the inability of a group of users to collectively organize with a view to better managing local resources.

Because collective regulation is costly and, as we have just seen, cannot be assumed to arise exactly when it is needed, it is important to enquire into the outcome of unregulated common property (the open access situation is too well known to warrant a new discussion here). Moreover, even a collective regulation regime requires that people act in a non-regulated manner (in a non-cooperative way) to bring it about. Indeed, if resource users, or a sufficient number of them, do not decide to contribute in a significant way to collective actions leading to the establishment of a resource management scheme, such a scheme will never come to light. Lastly, for people to have an incentive to participate in collective regulation, what they earn under the collective arrangement must exceed what they obtain in the absence of regulation. This condition constitutes their so-called participation constraint. In other words, the equilibrium outcome under unregulated common property provides a benchmark against which resource users evaluate the usefulness of a coordinated management scheme. For all these reasons, attention in Part 2 will be focussed on the outcomes of games representing decentralized patterns of interactions among resource users. These games are essentially static, thus mirroring the existing state of economic theory on the subject. In Part 3, the implications of the analysis under Part 2 for the design of collective regulation mechanisms will be investigated.

**Part 2 : Simple models of noncooperative behaviour and some implications for cooperative behaviour**

Since in reality there is a rich variety of common property situations, it is impossible to account for all of them in terms of a single analytical model. Three main models are considered in detail below. The first model examines a situation where users share the benefits from joint exploitation of a common property resource in direct proportion of the relative amounts of their appropriation efforts which they freely decide. The second model depicts the classical problem of voluntary contributions to a pure public good. As for the third and last model, it is based on the assumption that users benefit from the common good produced (or the public bad avoided) with the help of their aggregate contribution in proportion of their predetermined share or 'interest' in this good. The impacts of income inequality and group size will be analysed with respect to each model while that of the presence of exit opportunities will be considered only in terms of the third model which is particularly suitable for that purpose.

The core versions of the three models are discussed in three successive subsections while a number of interesting variants around the third model are examined in a separate subsection following the main presentation. Before Section 18.4 is concluded, we leave the framework of completely decentralised decisions to address an oft-neglected issue, that of the impact of inequality on collective regulation. Like in the previous sections, references to the relevant empirical literature are provided whenever appropriate.

### 18.2.1 The first model: the appropriation problem

#### 18.2.1.1 The problem

Consider a situation in which agents jointly exploit a common property resource by individually choosing their individual level of harvesting. Villagers thus decide the number of hours they spend in the forest gathering fuelwood, fishermen decide the number of boats they operate in a common fishery, or herders decide on the number of animals to let graze on the common pasture,… In all these situations, the level of harvesting effort decided by an individual agent has an impact not only on the collective level of exploitation of the resource, but also on his share in collective harvest which is usually directly proportional to his effort level. In contrast with the analysis proposed in the next sections where individual shares in the collective output are pre-determined, we consider here the case where individual shares are endogenous.

Assume that $n$ agents jointly exploit a common property resource and share their benefits in direct proportion to the relative amount of appropriation efforts they have chosen to put in. Let $g_i$ stand for the appropriation effort of agent $i$. Total output can then be written as:

$$G = G\left(\sum_j g_j\right)$$

where $G''<0$ and $G'$ can be positive or negative. For the sake of notational simplicity, we assume that costs are nil, so that the profit accruing to agent i is simply:

$$\Pi_i = \left(g_i \Big/ \left(\sum_{j=1}^{n} g_j\right)\right) G\left(\sum_j g_j\right)$$

In a Nash equilibrium, each agent maximizes his profit by choosing his own level of effort, taking the level of effort provided by the others as given. Raising the level of effort has two separate effects on profits: it may increase (or reduce) the aggregate output to be shared by all users, and it increases the individual's share in aggregate output. This is expressed in the first-order condition:

$$\frac{\partial \Pi_i}{\partial g_i} = \left(\sum_{k \neq i} g_k \Big/ \left(\sum_{j=1}^{n} g_j\right)^2\right) G\left(\sum_j g_j\right) + \left(g_i \Big/ \sum_j g_j\right) G'\left(\sum_j g_j\right) = 0$$

In the above equation, the first term is always positive. In equilibrium, the second term must therefore be negative, which implies that at the Nash equilibrium agents set the total amount of effort in such a way that its marginal productivity is negative (or, if costs were positive, below marginal cost). Inefficiency arises because, at the efficient point where marginal productivity is nil, agents have an incentive to increase their effort level since it increases their share in aggregate output[6].

18.2.1.2 The impact of inequality

As the objective functions of the individual users are profit (and not utility) functions, wealth or income inequality has no direct impact on individual or aggregate level of effort. When utility functions instead of profit functions are used to describe the objectives of resource users, as will be done in the next two sections, it is no more immaterial how wealth or income is distributed among these users as effort is then subject to income effects. This being said, the simple analytical framework presented above becomes useful to determine the impact of inequality when indirect effects operating through contraints on individual efforts are taken into consideration. More precisely, we contemplate the possibility that the distribution of wealth translates into a distribution of the constraints on the amount of effort that an agent can choose (see Baland and Platteau, 1999, for numercial examples). For example, to decide the number of boats to buy, a fisherman must have enough initial wealth either to directly finance the purchases of these boats or to secure access to the credit market. Absent this constraint, all individuals contribute the same amount of effort regardless of their wealth. On the contrary, if the constraint binds, poorer fishermen are constrained while wealthier users freely decide their level of effort. Consider a disequalizing transfer from (i) an agent who was previously unconstrained and is now constrained, or (ii) from an agent who was previously constrained to an unconstrained (wealthier) agent. Such a transfer has the effect of reducing the aggregate level of effort, thereby making the use of the common resource more efficient.

To show this result, let us consider the first-order condition above. Suppose that the transfers benefitted an unconstrained agent[7] (we leave to the reader the discussion of the case where such transfer benefits a constrained agent). The constrained user, who lost from the

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[6] Note that, if the users on the commons are simultaneously Cournot competitors on the output market, there exists an optimal number of users such that the commons is efficiently used (see Cornes et al, 1986)

[7] If more than one agent benefits from the transfer, one can always decompose the transfer as the sum of successive transfers to a single agent. Similarly, if the transfer originates from more than one agent, one can

transfer, reduces his own level of effort (by an amount equal to the change in his constraint). If after the transfer, the benefitting user, who is unconstrained, increases his effort level so that the aggregate level remains unchanged, the derivative of the profit function given above would be negative: the first term on the R. H. S. would be smaller, and, bearing in mind that $G'$ is negative at the Nash equilibrium, the second term would be more negative.[8] Hence, the post-transfer level of effort chosen by this agent will never be such that the aggregate level (increases or) remains constant. As can be checked from the F.O.C. above, he does increase his level of effort (i.e., efforts by the agents are strategic substitutes in this model), but this increase is smaller than the reduction in the effort levels of the loosing agent. It should be noted that, in some circumstances, a disequalizing change in the distribution of wealth may have such an impact on the aggregate level of effort that the welfare of all users is increased. Further discussion and details can be found in Baland and Platteau (1997b).

In a recent contribution, Bardhan et al (2000) propose an alternative approach for the analysis of wealth inequality in an appropriation problem. In their model, the production function includes two complementary inputs, the amount of appropriable resources from the commons (as in the traditional approach to appropriation problems described above) and a private input. To analyze the effects of wealth differences, they assume that the amount of private input owned is equal to own wealth and that the market for the private input is largely imperfect. They then show that greater inequality, in general, tended to reduce the efficiency of the decentralized outcome.

Another alternative approach would simply consider that the cost of the input for use of the common property differs across users, with lower costs for presumably wealthier users. This is the approach followed by Aggarwal and Narayan (1999). These two authors propose an interesting model of groundwater appropriation in a dynamic two stage game, where, in the first stage, players determine their extraction capacity (which represents the

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[8] Since $g_i$ increases while $\sum_{j=1}^{n} g_j$ is assumed to be constant, $\sum_{k \neq i}^{n} g_k$ is smaller; as a result of which $\left( \sum_{k \neq i} g_k \Big/ \left( \sum_{j=1}^{n} g_j \right)^2 \right)$ is also smaller. On the other hand, $\left( g_i \Big/ \sum_{j} g_j \right)$ increases, causing the second term to

maximal depth of extraction), while in the second stage, they decide their extraction path over an infinite horizon (that is the rate of utilization of this capacity). Assuming that the cost of capacity varies across agents (for instance, as a function of initial wealth under imperfect capital markets), they show that inefficiency in extraction is a U-shaped function of mean-preserving spread in the costs of capacity[9]. While this paper can be commended for its genuine effort to explicitly bring dynamic considerations into the analysis of common property resource, the approach to inequality directly equates a mean-preserving spread in wealth (which makes sense as a comparative statics experiment) to mean preserving spreads in input costs, which are less closely related to inequality. It is not clear that these two concepts are strictly monotonic to one another. To see this, consider the case where, below a certain wealth level, agents do not have access to formal capital markets and must turn to the moneylender for the purchase of the input. Clearly, then, any reduction in their wealth cannot change their input cost. In this situation, a mean-preserving spread in wealth reduces the input cost of better endowed agents (as they have more collaterals to offer on the formal credit market) while leaving this cost unchanged for poorer agents. Such a disequalizing change increases aggregate harvesting. These effects are totally different from those of a mean-preserving spread in input costs, which would imply that the input cost rises for the lesser endowed agents. Such effects are also at variance with those obtained under a different scenario, where rich users have an unlimited access to the formal capital market. In these conditions, an increase in the wealth of the rich does not change their input price, while poorer agents are driven out of the formal market by the reduction in their wealth. Clearly, caution is required when interpreting results based on mean-preserving spreads in costs rather than in wealth.

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be more negative. The FOC is therefore violated.

[9] As such capacity can be more generally interpreted as a fixed cost, poorer agents may even decide not to invest at all. The analysis is partly motivated by evidence on groundwater extraction in India, where poorer farmers did not generally invest in wells, or invested in wells of low depth. They were quickly driven out by the decline in the water tables (see Bhatia (1992) and Aggarwal (2000)). Similarly in fishing, poor artisanal fishermen may prove unable to purchase the type of high-powered vessels used by richer investors. As a consequence of this technological race, their access to the resource is reduced to the point of crowding them out of the sector.

18.2.1.3 The impact of group size

In the above model, the impact of an increase in the number of users can easily be established. Indeed, given a Nash equilibrium among $n$ agents, as described by the above first order condition, a new agent entering into the resource will always decide to exert a positive amount of effort (since the average return to effort is positive). The other agents will react to this increase in the use of the commons by reducing their own level of effort, but never to such an extent that the total level of effort diminishes (this can be shown by totally differentiating the first-order condition for agent $i$ with respect to an increase in effort by others). As a result, an increase in the number of users unambiguously raises the Nash equilibrium level of exploitation of the resource, thereby increasing the inefficiencies of its joint use (see also the discussion in Dasgupta and Heal, 1979: 55-73).

### 18.2.2 The second model: voluntary contributions to a pure public good

18.2.2.1 The model

The management of common property resources often involves the production of public goods, such as water control infrastructure, drains in watersheds or a fishing pier. Moreover, as will be argued later, participation in tasks of collective organisation such as maintenance of resource-related infrastructures, monitoring abidance of management rules, protection of the resource against outsiders,… can also be analyzed as a problem of voluntary contributions to a public good.

Consider a group of $n$ consumers, with utility functions:

$$U_i = U_i(x_i, G),$$

where $x_i$ represents the amount of private good consumed by consumer $i$, and $G$ is the amount of public good in the economy. The public good, $G$, is equal to the sum of the gifts, $g_i$, made by each consumer $i$, so that:

$$G = \sum g_i.$$

Each consumer $i$ is endowed with a level of wealth $w_i$, which he allocates between his consumption of the private good, $x_i$, and his donation, $g_i$. Letting $G_{-i}$ represents the sum of all gifts made by all the consumers other than i, we can define a Nash equilibrium as a vector of gifts ($g_i$*) such that, for each $i$, ($x_i$ *, $g_i$*) is the solution to the following maximisation problem:

$$\max_{x_i, g_i} \; U_i(x_i, g_i + G_{-i}^*) \quad s.t. \quad x_i + g_i = w_i, \quad g_i \geq 0,$$

in which the last constraint requires gifts to be non-negative. In other words, a consumer cannot resell the public good provided by the others in order to increase his own consumption of the private good.

Bergstrom, Blume and Varian (1986) propose an interesting reformulation of the problem which considerably simplifies the analysis and provides the key intuition for the comparative statics results. Let us concentrate on the choice made by one consumer. When he decides the amount of his gift, consumer $i$ chooses simultaneously the equilibrium level of $G$ itself: indeed if he chooses to make zero gift, he chooses $G = G_{-i}$, and if he chooses to make a positive gift, he chooses $G > G_{-i}$. Thus, the maximisation problem above can also be written as:

$$\max_{x_i, G} \; U_i(x_i, G) \quad s.t. \quad x_i + G = w_i + G_{-i}^*, \quad G \geq G_{-i}^* .$$

In other words, we can choose to make the total amount of public good provided by the other agents of the economy to appear explicitly in the budget constraint of consumer $i$. The above problem can be easily represented with the help of a standard consumer theory diagram, This is done in Figure 1 which has been drawn for a consumer who chooses to make a positive contribution in equilibrium.

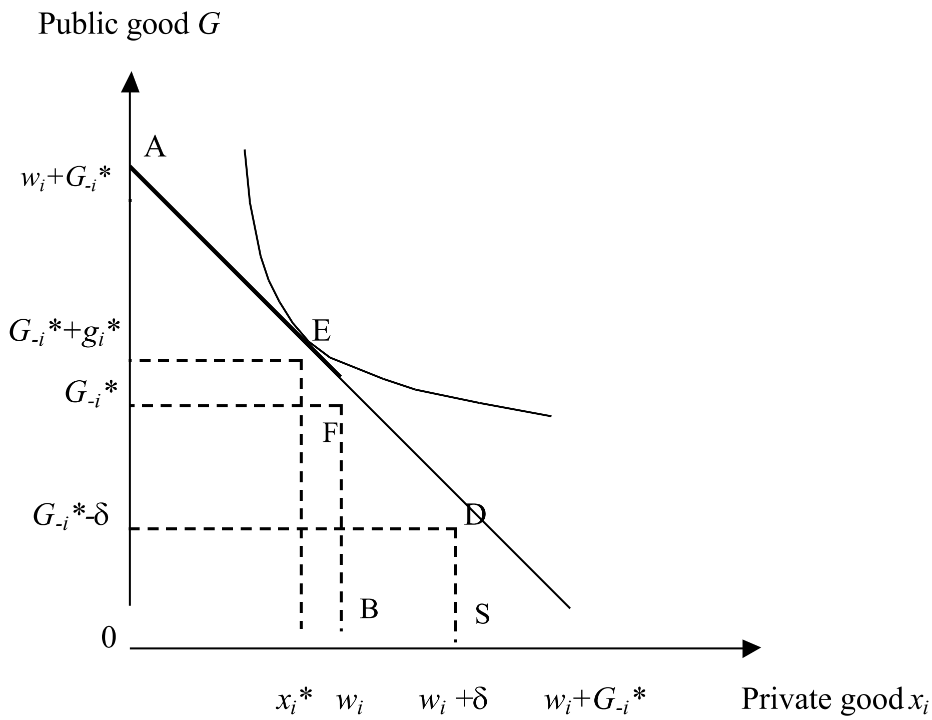


Figure 1: Consumer choice with voluntary provision to a public good

In Figure 1, the bold segment of the 45°-line represents the feasible points on the budget line of consumer $i$, under the restriction that voluntary gifts, $g_i$, are non-negative. At the equilibrium, consumer $i$ chooses to consume $x_i$* and to contribute $g_i$*, so that the total amount of public good in the economy is equal to $G_{-i}* + g_i*$. In the equilibrium, if we consider the set of all agents, while some of them choose to contribute positive gifts, others may decide not to contribute at all and to select the corner solution ($w_i$,0) in which they spend all their individual income on the private good.

Bergstrom et al.(1986) demonstrate that there exists a unique Nash equilibrium of this game. This equilibrium is typically inefficient. It can also be easily characterized if we assume that all consumers have identical preferences and that the public good is a (strictly) normal good. In such circumstances, there is a critical level of wealth, $w$*, such that, below that level, all consumers choose to spend all their income on the private good. All consumers with a higher level of wealth choose to contribute a positive amount which is exactly equal to $w_i$-$w$*. Indeed, as they all consume the same amount of public good, those agents must also consume the same amount of private good. (Suppose that this is not the case: consider an agent who chooses to consume more private good. Since $G$ is a normal good, this agent would also choose to consume more public good, hence a contradiction.)

18.2.2.2 Impact of changes in the income distribution

Equipped with the above simple analytical framework, we can now examine the effects of changes in income distribution on the equilibrium amount of public good[10]: by contrast with the preceding section, the use of utility functions allows for income effects to play a role in the determination of individual contributions. While preferences can differ across agents, we still assume that $G$ is a (strictly) normal good. We first analyze redistributions of income among contributing agents such that no consumer looses more income than his original contribution.

Consider agent $i$ who has received δ more units of income. Suppose that, after the redistribution, all other agents contribute exactly their original contribution minus δ. In other words, they, as a whole, reduce their contribution by exactly the amount of net wealth that has been transferred to agent $i$. In such a situation, the budget line of agent $i$ is exactly identical to the original one, since it is now equal to $(w_i+\delta)+(G_{-i}*-\delta)$. His budget set is now enlarged from AFBO to ADSO in Figure 1. Agent $i$ thus chooses exactly the same equilibrium bundle E than before: he consumes $x_i*$ units of the private good and contributes $g_i*+\delta$ to the public good. The extra amount consumer $i$ decides to contribute to the public good is equal to his income change, provided that all other consumers do likewise, which implies here that they reduce their aggregate contribution by δ. Since this is true for all agents between whom income has been redistributed, the equilibrium level of the public good is unaffected by non-drastic transfers betweeen contributing agents. In other words, income redistribution among contributors has no effect on the equilibrium amount of the public good as long as the set of contributors is left unchanged (which is guaranteed here by the fact that no one looses more than his original contribution). This result is known as the 'neutrality' theorem, and has been

[10] For a related discussion in the sociological literature, see Oliver et al.(1985), Oliver and Marwell (1998) and Heckathorn (1993).

originally discovered by Warr (1983) (see also Becker (1974, 1981), Cornes and Sandler (1985)): "When a single public good is provided at positive levels by private individuals, its provision is unaffected by a redistribution of income. This holds (…) despite differences in marginal propensities to contribute to the public good." (Warr, 1983: 207)

Before turning to other types of income transfers, it is worth stressing three important conditions that must be met for this result to hold: (1) no contributor looses more than his original contribution, (2) G is a pure public good, and (3) the consumers' utility does not depend on his own gift, but only on the aggregate amount of public good provided.

As we have assumed that the public good is a normal good, the intuition suggests that changes in the distribution of income that increase the aggregate wealth of the contributing agents increases the equilibrium amount of public good provided (see proposition 4 in Bergstrom et al.(1986)). This holds true for simple transfers of wealth from a non-contributor to a contributor, but it also applies to more complicated redistributions of income, which, for instance, involve that a former contributor has become too poor to continue contributing. The critical factor in this result is that the aggregate wealth of the set of contributors is increased. As the preceding result has made clear, the way this increase is distributed among them is of no consequence.

However, as consumers can differ in preferences, the redistribution of income discussed here cannot be directly related to inequality. Indeed, nothing so far prohibits a situation in which poor consumers, who have a 'strong' preference for the public good, contribute while the rich consumers, with other preferences, do not have a high enough income to be induced to contribute. In such a situation, redistributions of income that would increase the aggregate provision of the public good are equalizing. That would not be the case, however, if all consumers have the same preferences. Since contributions are then increasing with income, it immediately follows that disequalizing transfers increase the aggregate provision of the public good, provided that the transfers increase the aggregate wealth of the contributing agents. In particular, if a contributor looses more than his original contribution to the benefit of other contributors, aggregate contributions rise. This is because, as explained in the above section, there is a critical level of wealth below which an agent does not contribute. Transferring an amount equal to his contribution to other contributors does not change the aggregate level of the public good, but the extra amounts transferred increase it as they are equivalent to a transfer from a non-contributing to a contributing agent. It then follows that the smaller the set of contributors with a constant level of aggregate wealth, the larger the aggregate provision of the public good. The highest level of public good will be provided if the whole income is concentrated in the hands of a single consumer.

Some of these predictions were tested in a laboratory experiment by Chan et al.(1996) (for surveys of related experimental evidence, see Ostrom (2000) and Ledyard (1995)). An important result is that redistributing income from non-contributing to contributing individuals increases the aggregate provision of the public good. The experiment also shows that poorer individuals tend to contribute more and richer individuals less than what could be predicted on the basis of the model.

18.2.2.3 The impact of group size

The effects of group size on the collective provision of a public good can easily be derived from the above discussion.[11] Indeed, as long as the public good is strictly normal, an increase in the number of agents in the economy such that the wealth of the original members is unchanged can have two effects. The new agents can be non-contributors. In this case, the aggregate wealth of the contributors is unchanged and the equilibrium level of public good provided is left unaffected. Alternatively, the new agents can be contributors, in which case, the equilibrium level of the public good also increases, in a way similar to that resulting from an increase in the aggregate wealth of the contributors. It is possible that, individually, former contributors reduce their contributions, yet the aggregate level of G must be higher in the new equilibrium. As a result, an increase in the number of agents in the society which leaves the wealth of the original agents unchanged does not reduce the aggregate provision of the public good.

If the marginal propensity to consume the public good is close to zero, contributors will reduce their contributions by almost the same amount as the voluntary contribution of the

[11] Formal proofs of what follows can be derived by adequately reinterpreting the discussion on state provision of public goods and Theorem 6 in Bergstrom et al.(1986:42).

new agent. In equilibrium, therefore, the level of provision is hardly modified. In this situation, the contribution of the new agent almost completely crowds-out the original voluntary gifts. In contrast, if the marginal propensity to consume the public good is close to one, the income effect of the new contribution is almost entirely spent on the public good. As a result, the equilibrium level of the latter is increased by almost the same amount as the contribution of the new agent: the crowding-out effect on former contributions is negligible[12]. These two cases are illustrated in Figure 2 below, where the contribution of the new agent is indicated by Δ, the indifference curves AA depict the case of strong crowding out while the curves BB depict the case of weak crowding out.

As we have emphasized above, the increases in group size discussed so far are not supposed to change the wealth of the original members of the society. Suppose now that the new members do not bring any wealth of their own but receive transfers from the original members of the society. In this case, four different situations can obtain. First, the new members' wealth comes from former non-contributors and the new members decide not to contribute: the equilibrium level of the public good is then unchanged. Second, the new members' wealth also comes from non-contributors but the new members decide to contribute to the public good. The aggregate level of the public good is increased. Third, the new members' wealth comes from contributors and they decide not to contribute: such a change decreases the aggregate provision of the public good. Lastly, the new members' wealth comes from contributors and the new members contribute. The equilibrium level of the aggregate contributions will increase, stay constant or decrease depending on whether the set of contributors is larger, equal or smaller than the original one (since the aggregate wealth of the contributors is left unchanged). The main conclusion is therefore that, even if the new members do not bring any new resource to the society, so that, on average, original members

[12] One would expect that, when the public good is an inferior good, the new contributing agent will cause a more than proportional decline in the provision by the others, which would reduce the aggregate provision of the public good. Conversely, when the private good is an inferior good, the aggregate provision will increase more than proportionately to the contribution of the new agent. Unfortunately, since it is not clear that the Nash equilibrium is unique under those conditions, the comparative statics become less meaningful (see also Chamberlin (1974)).

of the society are poorer, the equilibrium level of the public good provided does not necessarily fall[13].

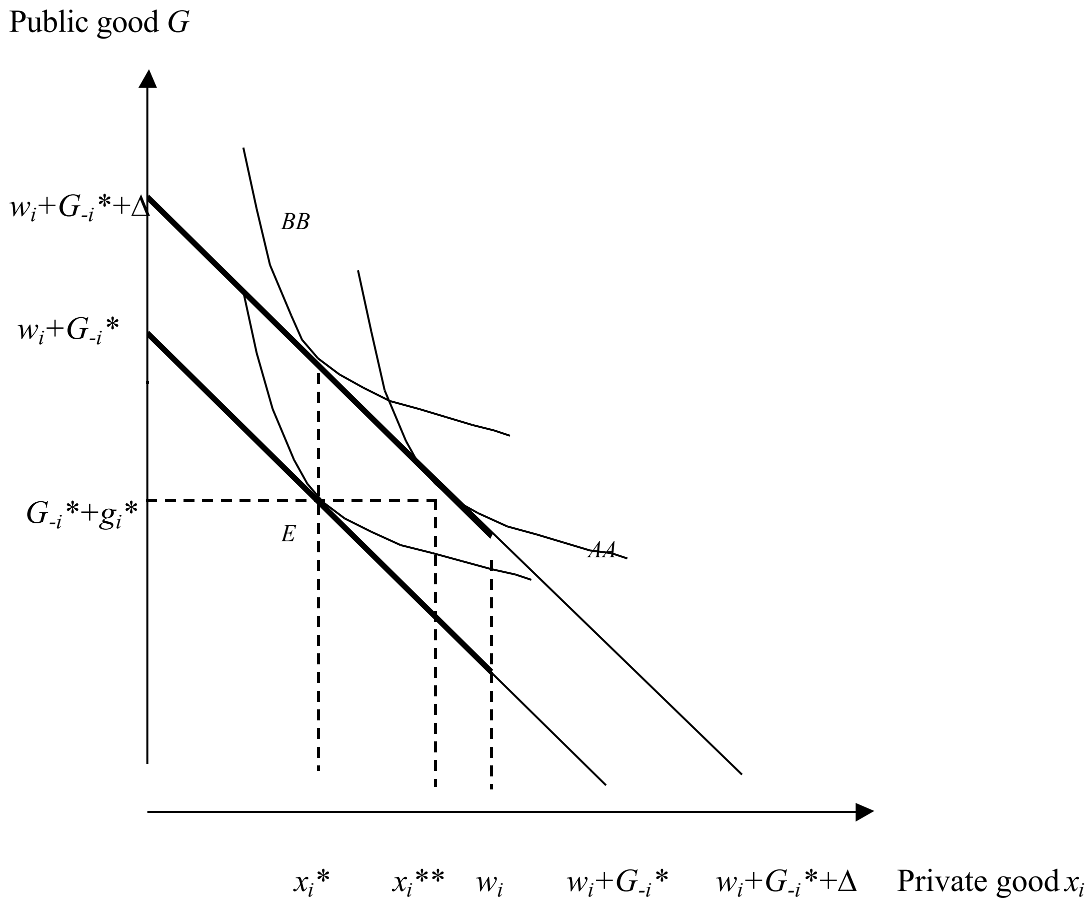


Figure 2: Group size and voluntary provision to a public good

### 18.2.3 The third model : Voluntary contributions to a common good

18.2.3.1 The problem

Think of the use of large mesh-sized nets to avoid capturing immature fishes by means of small mesh nets in a common fishery, or the building and maintenance of anti-erosive barriers in a hilly area, or else the collective maintenance of irrigation channels. In all these situations, the benefits of the 'public good' (which is called common good in what follows) provided are not enjoyed by all agents in the same proportion. Clearly, it is the fisherman with the largest fleet, and therefore the largest share in total fish catches, who benefits most from the protection of juveniles through the adoption of appropriate mesh sizes. In these circumstances, the agents benefit from the common good produced (or the public 'bad' avoided) in proportion to their share or their 'interest' in the good. This share is often directly related to their ownership of the relevant factors of production. Thus, in the case of a fishery composed of *n* fishermen, the share of fisherman *i*, $s_i$, can be thought of as being equal to the number of boats he owns, $B_i$, in proportion to the total number of boats in the fishery, if we assume that only one type of boat technology is available. Similarly, the share of farmer i in the collective irrigation system, $s_i$, is (at least for the sake of many of the relevant issues) equal to the ratio of his landholdings to the total service area operated under this system. His share in the benefits of the common good can thus be written as[14]:

$$s_i = \frac{B_i}{\sum_{j=1}^{n} B_j}$$

We consider a set of agents who voluntarily contribute an amount $g_i$ to the creation of a common good, *G*, of which they draw benefits in proportion of their interest, $s_i$, which is given (in the model examined in section 2, interests were endogenous). In a Nash equilibrium, each agent *i* maximizes:

$$\max_{x_i, g_i} \; U_i(x_i, s_i(g_i + G_{-i}^*)) \quad s.t. \quad x_i + g_i = w_i, \quad g_i \geq 0,$$

<u>18.2.3.2 Impact of changes in the income distribution</u>

As one can immediately see in the above equation, two dimensions of wealth distribution are worth discussing: the distribution of 'income', $w_i$, and the distribution of 'shares', $s_i$, which we consider in turn.

[14] We use this representation for simplicity. All the results discussed in this section would also hold with a more general definition of $s_i$, such as $s_i = f(B_i, \Sigma_j B_j)$, with $f'_1>0, f'_2<0$. If different boat types exist, $B_i$ can be measured in terms of engine horsepower, for example.

Assume as in the second section that the common good is a strictly normal good (i.e., the marginal propensity to consume those goods is strictly positive). In these circumstances, the model is identical to the pure public good model. The difference of shares between two agents can indeed be simply reinterpreted as a difference in preferences, which the model of public good analyzed in section 1 allowed for. The effects of changes in the distribution of income, $w_i$, are then identical to the ones reported there. In particular, any change in the distribution which increases the aggregate income of the contributing agents increases the provision of the public good.

We can now turn to the distribution of shares, $s_i$. Assume that agents have the same preferences and face the same constraints. In the Nash equilibrium, there is a critical share such that all agents with larger shares provide positive contributions, while those with smaller shares do not contribute. Also, contributions are increasing with the share of the contributing agents. As a result, any disequalizing transfer of shares from a non-contributor to a contributor increases the overall provision of the common good[15]. The impact of transfers between contributors is ambiguous, if we do not make additional assumptions on the utility function. It will actually depend on whether the increased contribution by the winning agent outweighs the reduction decided by the loosing agent. However, it is clear in this framework that the largest and most efficient voluntary provision of the common good occurs when a single agent concentrates all the shares, in conformity with Olson's (1965) well-known contribution.

18.2.3.3 The impact of group size

The impact of an increase in group size will depend a lot on whether or not the existing shares have to be redistributed or not. Consider the case of an irrigation network, and the common good under study is the maintenance of the main canal. The benefits of such maintenance to a particular farmer are proportional to the irrigated area he cultivates. Suppose that some farmers, in the proximity of the irrigation scheme, decide to convert their lands into irrigated fields. This decision does not increase the maintenance costs of the main canal, nor does it alter

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[15] The above results also hold true if the distribution of income closely follows the distribution of shares, so that agents with higher shares have a higher income as well.

the shares of the former users, but it increases the number of beneficiaries in the scheme, as it adds new 'shares'. In such a situation, if the new users voluntarily contribute a positive amount to the scheme, the new equilibrium level of aggregate contributions will be higher. If the new users decide not to contribute, it will be left unchanged.

The situation will however be different if the total amount of shares is left unchanged. With an increase in group size, the existing shares have to be redistributed among a larger number of users. The impact of such a redistribution on the aggregate provision of the public good will depend on the precise pattern of redistribution that takes place. For instance, suppose that the new users contribute in the equilibrium, and have obtained their shares from small agents, who previously did not contribute. This unambiguously increases the aggregate supply of the common good. Suppose conversely that the new users do not contribute in equilibrium and have obtained their shares from a large contributor, who, after the transfer, decides not to contribute any more. This transfer unambiguously reduces the aggregate provision of the common good. The effects here are thus closely related to our discussion on the impact of a redistribution of shares. But the essential point is that, even when shares have to be redistributed towards new users, an increase in group size does not necessarily reduce the level of the common good in the economy.

### 18.2.4 Variants around the third model

#### 18.2.4.1 The linear approach

Many analyses of cooperation on common property resources adopt a model which is, in essence, very close to the one presented in the above section. They may nevertheless propose different assumptions regarding the objective function of the agents, or the technology, which we now discuss.

In many contexts, the use of a general utility function is not adequate and, as in the model of section 1, one may prefer the use of a profit function of the following form:

$$\Pi_i = -g_i + s_i G\left(\sum_j g_j\right)$$

where $G$ is a concave function of aggregate contributions by all agents (non-linearity is needed to avoid unbounded solutions) while, as above, $g_i$ represents the contribution by agent $i$, and $s_i$, his share in the benefits of the common good[16]. Consider that agents choose the level of their individual contributions to maximize profits. In a Nash equilibrium, the first-order condition for an interior solution is:

$$-1 + s_i G'\left(\sum_j g_j\right) = 0$$

which we obtained by deriving the profit function above with respect to $g_i$. Note that, for this condition to hold, $G'$ must be positive. In equilibrium, as $\left(\sum_j g_j\right)$ is the same for all agents, the above equation cannot be satisfied for more than one agent: if it holds for agent i, with share $s_i$, it cannot hold for an agent with another share $s_j$, with $s_j \neq s_i$. In equilibrium, the agent with the largest share is then alone to contribute. All others will choose to free ride (the corner solution) and set the level of their contribution equal to zero. (If there is more than one agent with the highest share, there is a continuum of Nash equilibria such that all the agents with the highest share collectively contribute according to the first-order condition above.)

Comparative statics on the Nash equilibrium follow easily. Any change in the distribution of shares such that the level of the highest share is increased does raise the level of contribution to the common good. Small transfers between non-contributing agents (small enough so that none of them gets a larger share than the highest one in the original situation) and increases in group size (that does not affect the share of the contributing agent) have no impact on the common good.

18.2.4.2 Constraints on contributions

As in the case of models of appropriation, one may argue that people are not always in a position to contribute the amount they want. They may thus be subject to contraints on their

[16] One may argue that such an approach makes sense when the product of the resource can easily be sold on external markets. If the users cannot sell the resource output but uses it for self-consumption purposes, then the utility approach of section 2.1 is more appropriate.

feasible contributions (the utility framework used above had the same effect by allowing a varying marginal rate of substitution between the common good and individual gift). For instance, fishermen may contribute to the conservation of the fishery by releasing immature fishes caught in their nets, but the amount they can contribute is clearly limited by the number of nets they operate. (At least, this is true unless they make contracts with other fishermen, yet such contracts are fraught with enforcement problems). Or, a farmer can usually contribute to anti-erosive works only on the fields he cultivates. (Doing so on neighbouring fields would also imply complicated, and perhaps infeasible, contracting). Starting with a situation in which every agent faces the same constraint, the Nash equilibrium will be such that agents with the highest share, $s_i$, contribute up to the level of their constraints (the L.H.S. of the first order condition above is positive for them), while agents with smaller shares do not. Consider now the effects of transfers in the capacity to contribute. Once again, disequalizing transfers of capacities from the non-contributing agents to the constrained contributors do increase aggregate contributions. Moreover, since the maximal contribution that an agent is willing to make is an increasing function of his share, transfers of capacities to the agent with the highest share also increase the provision of the common good. (A more thorough elaboration of this argument can be found in Baland and Platteau, 1997b: 458-72.)

Dayton-Johnson and Bardhan (1999) propose a more sophisticated two-period model designed to highlight the effects of asset inequality and constrained capacity to contribute on cooperation in a fishery[17]. Consider a group of two fishermen endowed with a fishing capacity (expressed in terms of the amount of catchable fish), $c_i$, who live for two periods. If total capacity exceeds the amount of available fish, each fisherman gets a share of it that is equal to his share of total capacity, $s_i$, defined as $s_i = c_i / (c_1 + c_2)$. Each fisherman has to choose how much to fish in each period, up to his own capacity. In period 1, the stock of fish is equal to $F_1$. Once fishing has taken place in period 1, what is left of the stock grows at a gross rate $r$ to constitute the stock in period 2, $F_2$. To keep the discussion simple, we assume that $c_i < F_1$ and that $c_1 + c_2 > rF_1$.

[17] See also Bardhan, Bowles and Gintis (1999).

We proceed by backward induction. In period 2, the two fishermen use their whole capacity (there is nothing to be gained from self-restraint in that period), so that the benefit to agent i is just equal to $s_iF_2$. In equilibrium, fishermen thus share the fish stock in period 2 in proportion of their capacities.

Let us now turn to period 1. Obviously, since $r$ is positive, efficiency requires catches to be nil in period 1: for each unit of fish caught in period 1, indeed, $r$ units of fish are foregone in period 2. Consider the problem faced by fisherman *1*. Let us begin by assuming that the other fisherman decides not to fish in period 1. Then, fisherman *1* will decide also not to fish a given amount of fish, say $g_1$ (that is, in the terminology used before, his contribution to the future common good), provided his future benefits of doing so outweigh the current cost, that is if $s_1 r g_1 > g_1 \Leftrightarrow s_1 > 1/r$. If this holds true for both fishermen, then conservation is a Nash equilibrium. In other words, if everyone's share in the future common good (harvest) is large enough, there is an equilibrium under which everyone makes his highest possible contribution to conserving the resource till period 2 is reached (contributions are naturally constrained since negative catches are not allowed in the first period).

Consider now a situation in which fisherman 2 operates in period 1. (If 2 decides to take some fish in period 1, since $c_2 < F_1$, and payoffs are linear in catches, he will always fish up to his capacity). Fisherman 1 will then decide to fish as much as he can in period 1 if:

(1) $s_1 r(F_1 - c_2) < s_1 F_1 \Leftrightarrow c_2 > F_1(r-1)/r$. In other words, if fisherman 2 is large enough, he will catch enough fish in period 1 to deter fisherman 1 from leaving fish in the water (and share them in period 2 with fisherman 2). If a similar expression also holds for fisherman 2, then resource depletion in period 1 is also a Nash equilibrium.

It may also be the case that a fisherman, say fisherman 2, unilaterally decides to go out fishing in period 1, even though fisherman 1 decides to preserve the resource (i.e., the condition above is not satisfied). He then free rides on the conservation effort of the other fisherman, which occurs if:

(2) $s_2 r F_1 < c_2 + s_2 r(F_1 - c_2) \Leftrightarrow s_2 r < 1$. That is, if the share of fisherman 2 is too small to induce him to contribute to conservation of the fish stock.

Given these conditions, one can easily distinguish three types of situations. In the first situation, the shares of the two fishermen are not too different. The game then exhibits two

Nash equilibria, one in which both fishermen preserve the resource and the other one where they exhaust the whole stock in period 1. In the second situation, the shares of the two fishermen are different enough to make both conditions (1) and (2) simultaneously satisfied. Resource depletion in the first period is the unique Nash equilibrium. Finally, in a third situation, the shares of the two fishermen are very different, and it is a dominant strategy for the fisherman with the small share to fish in periods 1 and 2, while the larger one fishes only in period 2. Partial conservation is then the unique Nash equilibrium. As more shares are given to the larger fisherman (i.e. to the only contributor), the stock of the resource is better managed. Like in the other models, efficiency obtains if one fisherman concentrates all the shares. As the authors conclude, 'the relationship between inequality and conservation can be U-shaped: at very low and very high levels of inequality, conservation is possible, while for middle range of inequality, it is not' (Dayton-Johnson and Bardhan, 1999, 26).

In this model, the constraints placed on the capacity to contribute allow for situations of 'partial cooperation' (in which conservation of the resource is only partly achieved, with some agents contributing and others free-riding) because the agents with the larger shares are willing to contribute more but cannot do so. Simultaneously, the model realistically incorporates a particular technology with effects that are very similar to those of increasing returns: one's incentive to contribute is increasing in the contributions made by others. This yields different levels of 'cooperation' that could be sustained under a Nash equilibrium (for the same parameter values). In fact, such a multiplicity of equilibria is a common feature of all models of common good with increasing returns in contributions[18] and constrained capacities (see, e.g., Gaspart et al.(1998) examined below). It tends to appear when agents have similar shares in the common good. The inefficient situation in which no agent contributes vanishes when one agent concentrates enough shares and capacities to prompt him to contribute, even if he is alone to do so. However, as in the model of Dayton-Johnson and Bardhan (1999), an 'intermediate' level of inequality may distort incentives in such a way that the unique Nash equilibrium is characterized by the absence of any conservation effort, while, under a more

[18] If the production function is concave in the aggregate contributions, contributions by others reduce one agent's incentives to contribute. Those incentives are thus highest when contributions are nil (the inefficient situation). Such multiplicity cannot arise with a concave technology.

equal distribution, the efficient outcome is an equilibrium. (For similar results in the context of an anti-erosive management scheme, see Baland and Platteau (1997a)).

### 18.2.4.3 Non-convexities

So far, we have typically assumed that the technology was either concave or linear. (As discussed in Bergstrom et al.(1986:31), all the results that have been obtained with a linear technology also hold if the public good is a concave function of aggregate contributions.) However, there exist a number of situations related to common property resources where technology displays non-convexities and threshold phenomena[19], for instance because of set-up costs in the building of a common infrastructure, or because of a minimum threshold level beyond which the resource cannot reproduce itself and disappears. The above-discussed model of Bardhan and Dayton-Johnson (1999) actually incorporated such threshold phenomena.

We can illustrate the main impact of non-convexities on the voluntary provision to a public good with the help of a simple model proposed by Gaspart et al.(1998). Assume, as before, that agents can decide to contribute an amount $g_i$ to the building of a common infrastructure, such that $G(\Sigma_j g_j) = 1$ if $\Sigma_j g_j$ is greater or equal to a constant $C$, and $G=0$ otherwise. In other words, aggregate contributions must reach a critical level for the public good to yield any benefit. The discontinuous character of the production function can easily be justified for a number of collective infrastructures such as the building of a drain in watershed management (adequate drainage can hardly be achieved by a half-completed drain), the erection of contour bunds to prevent erosion, or the digging of a well. While such a model is arguably very specific, it captures in a simple way the main effects of a non-convexity (for a more general approach, see Baland and Platteau (1997b)). The profit function is the same as the one given above.

[19] See in particular Baland and Platteau (1997a) for a discussion of non-convexities in the realm of common property resources.

We also assume that no agent would have an incentive to produce alone, so that all shares are such that $s_i < C$. First note that there is a Nash equilibrium under which no agent contributes. It corresponds to a coordination failure so that no investment occurs, even though there are situations under which everyone, even those who contribute, would benefit from it. Clearly, even though one must not exclude a priori such an equilibrium situation, it remains unlikely in the type of closed and small communities we have in mind here (see section 18.4.6 below for a related discussion). Let us now look at the other Nash equilibria. Clearly, if the other agents contribute enough so that agent i's contribution is both profitable for agent i and needed for the production of the public good, agent i will contribute just the amount necessary for the completion of the public good. In other words, in a Nash equilibrium, agent $i$'s best response is:

$$\begin{cases} g_i = C - \sum_{j \neq i} g_j & \text{if} \quad C > \sum_{j \neq i} g_j \geq C - s_i \\ g_i = 0 & \text{otherwise.} \end{cases}$$

The reaction functions and the various equilibria of a two player version of this game are illustrated in Figure 3 below:

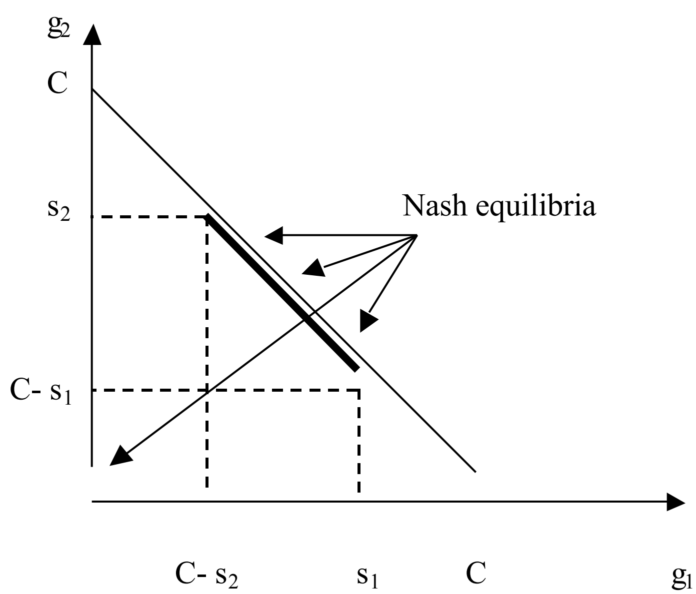


Figure 3: Reaction functions in a fixed cost model of a common good

The situation in which aggregate contributions cover the fixed cost of the public good (the bold segment in Figure 3) corresponds to a continuum of Nash equilibria which can be characterized by two conditions: (i) no agent contributes more than his own share in the common good, and (ii) the sum of all contributions equal the fixed cost $C$. While it is true that agents with larger shares will tend to appear more frequently in the possible equilibria, and that their equilibrium contributions will on average be more important, no further precise prediction can be inferred from this model. In particular, one can easily construct examples of equilibria in which only the smallest agents contribute to the public good[20]. Also, given the multiplicity of equilibria, it is hard to get meaningful comparative statics results. However, it should be noted that when the distribution of shares is such that one agent has enough shares to undertake the project alone $(s_i > C)$, the Nash equilibrium under which no agent contributes disappears. In other words, the coordination failure associated with the inefficient Nash equilibrium can be trivially solved by an appropriate transfer of shares.

The main lessons to be drawn from the above model is that the presence of non-convexities, which are particularly likely in the context of common property resources resources, imply multiple equilibria and the possibility of coordination failures. When non-convexities are likely, to deliver meaningful and relevant results, empirical approaches have to thus be tailored specifically to address these problems.

#### 18.2.4.4 Other technological assumptions

There are two alternative technological assumptions that are worth investigating. First, it is not clear that contributions are always continuous. In some instances, contributions are lump sum, or at least come into discrete amounts. Typically, participation to collective organizations require a minimum of physical presence to meetings and activities[21]. To

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[20] For instance, suppose that you have $n$ small agents,with share $s_S$, and 1 large agent with share $s_L$. If $n \cdot s_S > G$, there exist equilibria where $m$ small agents contribute $s_S$, with $m = G/ s_S$, while the others, including the large agent, contribute zero.

[21] In a recent paper, La Ferrara analyzed the determinants of participation to groups, who could exclude non-members from benefitting the collective good they provide to their members. While her theoretical analysis pointed to the ambiguous impact of inequality on participation, her empirical estimates on participation to informal groups in rural Tanzania supported the view that higher inequality at the village level was detrimental to the average level of participation (La Ferrara (2001), see also Alesina and La Ferrara (2000) and Di Pasquale

illustrate the type of questions that can be raised here, assume indeed that contributions are lump sum, that their cost is identical across all agents, and that benefits are linear in aggregate contributions. Two cases can then arise. First, interests, if equally divided, may not be important enough to motivate participation, say, because the resource is too poor relative to the number of potential users. In this case, the highest aggregate level of contributions will be reached by concentrating the distribution of interests on a subgroup of agents. By contrast, if equally divided interests are important enough, an increase in inequality, as well as an increase in group size, such that participation becomes non-profitable for some agents, reduce the aggregate level of contributions. The latter case may be related to the results obtained by Easter and Palanisami (1986) (as quoted in Bardhan et al, 2000) in their study of water organizations in India and Thailand. They found that a higher variance in farm size at village level is negatively correlated with the formation of water organizations. (Note that such formations may well be properly described by the above technology.)

Second, we have so far assumed that individual contributions are perfect substitutes : they can simply be added up to get the aggregate amount of contributions. The fungibility of money is the major argument behind the assumption of perfect substitutability of individual contributions. Since, in many collective undertakings, contributions tend to be made in kind (if only, by the physical presence of the agents concerned) rather than in cash, this assumption may not be adequate[22]. This is evident when people are of different skills or talents, or make their contributions by different ways that have to be combined together. The nature of the common good provided may also be such that contributions are not perfect substitutes : this applies when nothing short of universal participation may lead to its production.

Consider also the other polar case, in which contributions are perfect complements. The level of the common good is then limited by the contribution of the agent with the smallest incentive to contribute or the smallest interest. An equal distribution of interests obviously maximizes the aggregate contribution. Examples can be constructed where this holds true even when the elasticity of substitution is substantially high (above one).

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[22]Cornes and Sandler (1996 :184-90) propose an example of voluntary provision of a public good, where contributions are not perfect substitutes, and show that the 'neutrality theorem' fails to hold in this case (see also Cornes and Sandler (1994))

Inequality and exit opportunities

The importance of existing exit opportunities for the possibility of 'cooperation' on common property resources has often been emphasized in the literature. Agents who can easily substitute other income-earning activities for their working on the commons have less interest and less commitment towards its preservation. Alternatively, agents with better access to alternative income opportunities can be seen as users with a comparatively high opportunity cost of labour, which has the effect of reducing their participation in CPR management activities if these activities are in the form of labour contributions (Baland and Platteau, 1998a). These situations can usually be analyzed with the help of the model of provision to a common good discussed in this section, where agents with lower interests can be thought as those who enjoy better exit opportunities (for a more explicit discussion, see Dayton-Jonhson and Bardhan (1999)). The relationship between wealth and exit opportunities, however, depends on the specific context under analysis. For instance, while in some cases, agents with exit opportunities are poor migrants who can easily move to other places, in other cases, they are wealthy villagers who have access to outside employment or technologies which allow them to easily relocate their activities (such as owners of industrial vessels in the case of fisheries).[23] For instance, in a Ugandan forest participatory management scheme which we visited, villagers are regularly confronted to those two types of agents : there are poor charcoal-makers, who continuously shift from one place to another and entertain no genuine relation with local villagers, and there are rich businessmen from the capital city, who hire workers and own trucks in order to cut timber at night. (Those two activities are legally prohibited, but enforcement remains problematic).

The varying presence of exit opportunities may not only account for different rates of individual participation in the production of a local collective good, but also for varying degrees of success in organising and maintaining collective goods. As an example of the former,

[23] Note however that if labour markets are risky, poor migrants remain eager to retain their assets in the native village and to keep them in good conditions. In this way, indeed, they maintain access to a reliable fallback option.

one can cite the well-known situations where absent herd owners show much less restraint in their use of common village or peri-urban pastures than local residents whose incomes heavily depend on pastoral activities and have few possibilities of moving their herds elsewhere (see, e.g., Shanmugaratnam et al, 1992: 20-6). Analogous examples from the fishing sector are easily forthcoming where the opposition is between owners of industrial fishing vessels (say, bottom trawlers) that are essentially mobile and small-scale artisanal boats that are attached to local waters (see, e.g., Baland and Platteau, 1996: 303-4). As an example of the latter case, consider a cross-section study of irrigators' associations in 25 national irrigation systems (covering six provinces) in the Philippines, all under the command of the National Irrigation Administration (NIA). In their study, Fujita et al.(1999) have shown that there is a negative relationship between the effectiveness of collective action by water users and the availability of exit options from farm to non-farm economic activities.

So far, exit opportunities appear to have only negative effects on the ability and willingness of resource users to cooperate. Yet, positive effects may also be present that have to be balanced out against these negative effects before a final judgement is pronounced about the impact of exit opportunities (see, e.g., Tang, 1992: 21). More precisely, because of the highly imperfect credit markets that prevail in most rural areas of developing countries, resource users with access to other sources of income may be better able to participate in collective undertakings that demand substantial capital investment or sacrifice before producing benefits. In particular, it may require a significant reduction in the rate of harvesting to rehabilitate a degraded resource, be it to replenish a deteriorating water basin, to restore a village forest or grazing space, or to bring back vanishing fish species into the sea. We are here in a case where contributions to CPR conservation take the form of income or cash income rather than labour.

Absent outside income opportunities, an external intervention is needed to provide users with proper incentives to conserve their endangered resource. This explains the success of village-based reforestation schemes, such as the Arabari experiment in West Bengal (India) or the Guesselbodi forest reserve project in Niger, which have been attentive to the need of poor resource users to be duly compensated for temporary losses of income (Cernea, 1989). Clearly, the amount of assistance needed will depend on the bio-physical characteristics of the resource and, more particularly, on its level of productivity at the beginning of the incentive scheme. It is a priori possible that users require only a small trigger in order to move from a shutdown to a conservation path. At the other extreme, the possibility also exists that bio-physical conditions are initially so bad and/or conservation practices so ineffective that no conservation strategy is going to be profitable in the long run: production will never be sustainable, whatever the conservation efforts undertaken. In this case, there is no way out of creating alternative income-earning opportunities for the rural poor and, if the natural resources on which their subsistence presently depends have a value for the society, the sooner these new opportunities are created, the better it is (since the resources may be completely degraded if they come too late). Yet, if conservation is a feasible strategy, it bears emphasis that a policy of assistance to poor resource users is likely to be all the more effective as they have in general great incentives to seek to conserve their resource base precisely because they have limited alternative income sources (Baland and Platteau, 1996 : 294).

Assuming conservation to be feasible and socially desirable (say, on account of external effects), it would nevertheless be wrong to believe, as hinted at above, that only poor users require to be compensated during a critical resource recovery period. Indeed, users with attractive alternative income opportunities may have a strong incentive to follow a shutdown path of resource exploitation : if the rate of return on the resource conservation investment falls below the return achievable by allocating production factors to alternative uses, they will draw down the resource to the point where production cannot be continued since by so doing they can reap the high returns from resource overexploitation and, thereafter, shift to an alternative activity (Pagiola, 1993). Obviously, the amount of incentives required to make these fortunate users shift to a conservation path may be much higher than in the case of poor users. In this regard, it is revealing that, in northern India, farm forestry schemes have been much more successful in districts with poor laterite soils than in better-endowed districts (Baland and Platteau, 1996 : chap. 11).

To sum up, assuming perfect rural credit markets, the availability of alternative income opportunities is a factor adverse to effective collective action with respect to CPRs when it has the effect of raising the opportunity cost of labour or of reducing the users' interest in the resource. When real-world credit market imperfections and liquidity constraints are taken into account, however, access to such opportunities might prove useful, especially if poor CPR users enjoy the benefits of such access and conservation efforts are needed to restore the state of the resource.

### 18.2.5 Some lessons of the non-cooperative framework for collective regulation

By viewing the organizational tasks related to collective regulation as a common or a public good, one can draw a first set of implications regarding the setting up of a collective management scheme. First, the richer an agent is (in income, wealth, or 'interest'), the more he will tend to contribute. Voluntary contributions are increasing with wealth. This general result partially confirms Olson's intuition: 'the greater the interest in the collective good of any single member, the greater the likelihood that that member will get such a significant proportion of the total benefit from the collective good that he will gain from seing that the good is provided, even if he has to pay all of the cost himself.' (Olson, 1965: 34).

However, that contributions are positively related to wealth does not imply that regressive redistributions of wealth necessarily increase the aggregate provision of the public good, or the intensity of collective regulation. It is therefore wrong to conclude that: 'In smaller groups marked by considerable degrees of inequality (…) there is the greatest likelihood that a collective good will be provided' (Olson, 1965: 34). More precisely, when some poor agents do not contribute, redistributing income from those agents to contributing agents increases provision of the collective good. In contrast, redistribution between contributing agents has ambiguous effects. Still, it remains true that public good provision is highest when a single agent concentrates all the wealth, as Olson correctly hypothesized.

There exist a large number of case studies dealing with this issue which tend in their vast majority to confirm the hypothesis that agents with the highest interest contribute a larger share of the collective good. For example, in his in-depth study of irrigation systems in South-India, Wade demonstrates that the effectiveness of a local irrigation council 'depends on its councillors all having substantial private interests in seeing that it works, and that interest is greater a larger a person's landholding' (Wade, 1987: 230). The claims that large landowners can make 'are sufficiently large for some of them to be motivated to pay a major share of the organisational costs' (Wade, 1988a: 190).[24] A similar observation has been made by Gaspart et al.(1998) in their detailed analysis of voluntary participation of villagers to a watershed management scheme in Ginshi (Ethiopia). They indeed find a positive relationship between the size of one's potential interest and the amount of effort spent on the building site. (As the authors have pointed out, despite the indeterminacy of their theoretical results, the equilibrium selection process in the village studied has apparently been based on a norm of proportionality betweeen contributions and benefits.) In another study, Gaspart and Platteau (2001) have shown econometrically that in the Senegalese fishing community where effort-regulation schemes have been most successful, they have been strongly supported by an elite of wealthy and comparatively old fishermen who have played a major role in initiating and enforcing them. Similar evidence can be found for watershed management in Haiti (White and Runge (1995)), rural cooperatives in the Netherlands (Braverman et al.(1991)), grazing schemes in Lesotho (Swallow and Bromley (1995)) and in Rajasthan (Shanmugaratnam (1996)), erosion control in Mexico (Garcia-Barrios and Garcia-Barrios (1990)) forest management in China (Menzies (1994)) or irrigation systems in Nepal (Laitos (1986) and Ostrom and Gardner (1993)).

However, a number of empirical studies of irrigation schemes in developing countries conclude that higher inequality in landholdings (or farm income) tends to reduce the overall level of maintenance, even though it simultaneously induces larger agents to support a bigger share of the collective costs (see Tang (1991), Dayton-Johnson (1998) and Bardhan (2000)). This is in conformity with our above-stated proviso. Relatedly, in their analysis of sugar cooperatives in Maharashtra, Banerjee et al.(2001) show how the weight of wealthy and influential users in collective decision-making tends to distort collective regulation towards their interest, at the cost of efficiency. Their empirical estimates show that distortions (and inefficiency) in collective regulation tend to increase when inequality is larger among users.

Inequality affects collective regulation not only through voluntary participation in the organizational tasks involved, but also through the regulatory possiblities that the available instruments allow for. From this second standpoint, inequality appears as much less

[24] In the same study, Wade (1988a) also argues that small size might be detrimental to the success of collective action.

favorable to collective regulation. There are indeed a number of arguments to support the view that wealth or skills inequality between users makes regulation less efficient.

First, in the presence of inequality, regulation is more difficult to design and implement as regulatory instruments are imperfect[25] and are often limited to uniform quotas, or constant tax rates. Baland and Platteau (1998a), following Kanbur (1992), propose a number of examples aimed at highlighting this difficulty. In particular, as resource users are more different, the regulated solution tends to be less efficient. It is also more likely that some of the users will be hurt by the regulation proposed, in the absence of compensatory transfer schemes. As a result, if we require the regulated solution to Pareto-dominate the ex ante unregulated situation, as inequality rises, the Pareto-dominating regulation, if it exists, tends to be less efficient.

That the regulated outcome may not be efficient is an important conclusion that should prompt us to critically assess field experiences with resource management schemes. This is all the more so as there is a general tendency in the empirical literature to confuse the means with the end by inferring from the simple existence of regulatory instruments that the resource concerned is properly managed or conserved. Field enquiries typically focus on the question as to whether rules have been laid out and whether they are effectively enforced (what are the detection and monitoring methods used, what is the incidence of rule violation, etc.). For example, studies dealing with forestry or irrigation schemes have a tendency to describe in considerable detail the various rules established by a user community to regulate access to the forest or water as well as the monitoring and sanction systems created towards the purpose of enforcing them (see Ostrom, 1990, 1992 and Baland and Platteau, 1996: chap. 12 for references). An effort is then generally undertaken to identify the characteristics of those user communities that have shown their ability to devise and apply membership or use rules as though these rules were necessarily conducive to efficient management of local-level resources. Typically, the possibility that rules do not support an efficient outcome or that they are

[25] For a thorough discussion of the limitations in the use of such instruments, and in particular the importance of equal treatment of community members and the prohibition of monetary compensations, in the case of common property resources, see Baland and Platteau (1999: 782-4).

infringed because they are considered to be inefficient or hurting the interests of violators is rarely contemplated.

That regulation tends to be more difficult to implement in the presence of inequality is supported by the well-known analysis of shrimp fishery in Texas by Johnson and Libecap (1982):

> '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).

Given the inherent defects of uniform quotas (or taxes), one may wonder why more differentiated instruments are not put into practice. A first explanation is the information problem. Indeed, when information about individual performances of resource users is imperfect, the latter have an incentive to lie about their real endowments or their true use of the resource. To avoid endless arguments and conflicts, communities tend to have recourse to systems of uniform treatment of all users, irrespective of their type. Evidence from Senegal artisanal fisheries confirms that fishermen are reluctant to differentiate fishing quotas according to individual skill levels or performance. As noted by Gaspart and Platteau (2001), many fishermen actually denied that skill differentials exist in their community and they 'actually took pains to explain that better performances on the part of some fishermen are only transient phenomena likely to be reversed as soon as luck turns its back on them to favour other fishing units' (p. 14).

Another powerful motive against unequal treatment of different users rests upon the traditional ethics of village communities. Typically, indeed, access to communal resources is mediated through membership in a social group. The relation is 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, an unequal treatment of users would be considered to introduce or reflect a hierarchy of social status. In the same logic, communities tend to avoid monetary payments to a fraction of their members as such payments will be viewed by the people concerned as a manoeuvre aimed at buying their exclusion from customary entitlements [Berry, 1984; Bourdieu, 1977, 1980].

The literature dealing with CPR management in village societies actually abounds with examples of uniform quotas and taxes, or transfer payments destined for equalizing individual incomes. As illustrated by the case of Japan, uniform quotas can be observed even in rural communities characterized by strong economic differentiation. According to McKean (1986), indeed, in preindustrial Japanese villages, a relatively egalitarian treatment of all villagers with respect to use of local CPRs went hand in hand with inequality in private landholdings and political power (for similar systems in India and Nepal, see Guha, 1985, p. 1940; Arnold and Campbell, 1986, p. 436).

Three points remain to be made. The first one has to do with the impact of group size on collective regulation. This impact is actually ambiguous, and depends critically on the following factors: (i) whether initial wealth or interest has to be divided with the new agents or not, and (ii) whether the cost of providing the collective good increases with the number of users. Clearly, when new agents do not reduce the wealth of the former contributors, and when the cost of the collective good does not depend on the size of the user group, increases in group size has a positive impact on collective provision. (see e.g. Aggarwal and Goyal (1999) for an analysis of the case of scale economies in monitoring costs). By contrast, many empirical studies conclude that successful management schemes tend to be run by small user groups or communities (see, e.g., Ostrom (1990, 2000), Tang (1992), Wilson and Thomson (1993)).

Poverty is another important dimension which has not been touched upon. It is generally argued that poverty may drive people to contemplate short-term strategies, with heavy consequences for the future state of the resource (Baland and Platteau, 1996; Paggiola, 1993; Perrings, 1996)[26]. Typically, poor people do not have access to the capital market. They also tend to be more prone to adverse income shocks, with little ability to self-insure. When their income is low, they would be willing to dissave, that is to use credit markets to transfer income from future periods to the present, but they cannot. They will therefore use alternative and inefficient ways to dissave, as a substitute to their access to the capital market. One such means is to over-exploit the commons. Poverty, when it implies poor access to credit and insurance, is an additional factor of inefficiency in the use of the commons[27].. However, insofar as poor people have few alternative income opportunities available to them, they also tend to have more stakes, and thus more incentives, to take measures to protect common property resources.

Finally, for most of our analysis, we focussed on Nash equilibria in games of finite duration. While this may adequately represent a large number of field situations, there also exist cases where the game played by users on the commons is more realistically depicted as an infinitely repeated game. In such games, as is well known, there is a plethora of equilibrium strategies. In particular, the efficient outcome can be possibly sustained in equilibrium (see, e.g., Abreu: 1986, 1988). In such games, however, the problem becomes one of equilibrium selection. Such selection can be based on evolutionary processes (see in particular Sethi and Somanathan, 1996), social norms and customs, or other mechanisms. Such a study however clearly lies beyond the scope of the present review (for some insights, see Dasgupta, 1993; Baland and Platteau, 1996: chap. 12; Wade, 1988a, and the discussion in Bardhan and Udry, 1999: 173-7). It is probably in the context of infinitely repeated game that the literature emphasizes most the advantages of small-size for 'cooperation'. It is thus argued that in small and closed communities, people know each other well and can communicate easily (to coordinate on the 'good' equilibrium, for instance), reputation can play a role, and actions taken by others are easily observed. Also, people tend to be related through more dense and

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[26] In a recent contribution, Ternstrom (2001) examines the implications for cooperation on the commons of Dasgupta's hypothesis according to which, at low levels of income, an agent's utility is a S-shaped function of consumption. Under different settings, she shows that the prospects for cooperation are highest when agents' expected income is located around the inflexion point, where the marginal benefits of cooperation, and the costs of defection, are highest. Cooperation is less easily sustained when agents are poorer (or richer).

[27] For a parallel discussion relating to child labour and poverty, see Baland and Robinson (2000).

multiplex relationships, which makes defection in one sphere of social or economic life punishable in many other spheres, such as through social ostracism.

## Part 3 : Impediments to the design and implementation of efficient common property management systems

### 18.3.1 Information on resource characteristics

#### 18.3.1.1. Cognitive problems

People appear to be naturally inclined to believe that resources are abundant till the proof of the contrary is driven into their eyes and minds. Even when resources have been degraded, users may deny that they are responsible for the damage. This is typical of fishing and hunting societies which deal with resources which often move over vast territories and are part of complex ecological systems about whose functioning even specialists can strongly disagree. In particular, these systems are characterised by numerous chains of interdependencies among vegetal and animal species that make for unpredictable behaviours of harvestable elements. In these conditions, it would have been actually surprising that users have a clear and correct perception of the consequences of their actions.

Especially when resource systems have the kind of physical characteristics described above, users tend to view the flow product of a resource system as given rather than as an outcome which they may themselves influence through their own harvesting behaviour. In other words, they do not perceive the relationship that exists between the stock and the flow of a resource nor the causal link between their own actions and the level of this stock. Or, in technical terms, they are not aware of the existence of a sustainable yield curve in so far as they do not have a clear grasp of the fact that today's choices may constrain the set of future choice possibilities. As a result, they do not perceive themselves as actors in a strategic game resembling the Prisoner's Dilemma, as is generally assumed by economists. Or, in more general terms, they misperceive the game that they are playing.

The anthropological literature provides us with interesting examples of hunting and fishing societies where the agents of ecological destruction have a poor understanding of their role in this process. Particularly illuminating is the case of the *Ponams* fishermen of Papua New Guinea studied by Carrier (1987). They indeed opposed a government's plan aimed at the conservation of sea turtles which played an extremely important role in their life because they refused to ascribe the declining catches to a decrease in fish population. Instead, they held that catches fell because fish became wary: "fish themselves are the agents of ecological change and the cause of decreased catches" (Carrier, 1987: 153-55). Unlike the Western view which tends to see human action as the principal agency of ecological disruption, their conception was therefore based on the belief that external agencies are at the heart of environmental phenomena.

We have already mentioned the study of the Boreal Forest Algonquians by Brightman (1987). Although they could recognize their proximate role as agents in the destruction of animals (most notably, the beaver), these Indian tribes would never admit final responsibility, the ultimate cause of any ecological change being necessarily located in decisions of supernatural beings. The idea that hunting pressure could reduce species populations in the long term and on a large scale was all the more absent in traditional Algonquian culture that game animals killed by hunters were thought to spontaneously regenerate after death or reincarnate as fetal animals. Thus, *Cree* trappers could well imagine that "an adult, trapped animal was 'the same one' that had been killed the previous winter", thus reflecting their profound belief that their environment was one of primordial abundance. This ecological optimism was actually reinforced by the feeling that "game could not be destroyed but only temporarily displaced and that "animals were 'given' to hunters when they were needed" (Brightman, 1987: 131-33).

Interestingly, in another study describing the present-day life of the *Cree* Indian fishermen in the James Bay, Berkes has reached the same conclusion as Brightman and Carrier : at least up until recently, these fishermen believed that "fish is an inexhaustible resource, and that the numbers available are independent of the size of the previous harvest" (Berkes, 1987: 84). In the words of Berkes :

> "*Cree* practices violate nearly every conservation-oriented, indirect-effort control measure in the repertory of contemporary scientific fisheries management. In many

> of these [Inuit or Eskimo] groups, as with the *Cree*, it is the animals who are considered to be making the decisions ; hunters are passive. Any management system claiming to maximize productivity by manipulating the animals is considered arrogant" (Berkes, 1987: 85-86 ; see also Martin, 1979 : 285).

That the problem persists even to this date in both developed and developing countries is confirmed by recent observations, for example in marine fisheries. Thus, in Toyama Bay (Japan), Platteau and Seki (2000) have found that boat skippers have attempted to form groups, sometimes with durable success, in order to regulate fishing effort and limit fish landings. Yet, the stated motive behind these collective actions is not the conservation of the resource but the increase of fishermen's market power *vis-à-vis* merchants. Interviews with fishermen revealed their total scepticism regarding the idea that the stock of shrimps can be influenced by the total amount of fishing effort. For them, fish comes in the bay from elsewhere (from the open ocean where it spawns and breeds) and the quantity available for the current season is fixed and determined by ecological factors out of human control. If there is less fish in local waters this year as compared to last year, it is because, for some natural reason, fish has moved in greater quantities to an adjacent fishing space.

In an equally recent study, Gaspart and Platteau (2001) have shown that fishermen's statements about the need to conserve the fish stock may be delusive. In Senegalese villages where collective regulation of fish landings or sea trips has been carried out for at least several years, –quite an extraordinary achievement in itself–, the basic preoccupation of the fishermen has been with increasing producer prices rather than with managing the resource with a view to conserving it. When they mention biological effects, most of the time they do it in a perfunctory manner : the fact of the matter is that they do not seriously consider the possibility of their being partly responsible for overfishing and, therefore, the idea that they could combat environmental degradation by restricting their own fishing effort seems alien to most of them[28]. Revealingly, there is a clear tendency among them to externalise the problem

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[28] Another finding of Gaspart and Platteau's study is that fishermen who are relatively educated (they have more than six years of French or Coranic school) tend to mention biological effects (whether in conjunction with economic effects or not) more often than the other fishermen. The fact that environmental problems are nowadays a widely publicised issue, both at school and in the media, probably explains why many relatively educated fishermen refer to the biological effect of output regulation.

by blaming industrial fishing vessels, or migrant fishermen who operate other fishing techniques, for the destruction of fish resources[29].

The tendency to 'blame the other' for stock depletion is typical of almost all artisanal fishermen communities that operate in the world, including those in Europe. It is thus generally acknowledged that enforcement of fishing quotas laid out in accordance with the European Community's 'blue' policy is difficult as fishermen have various ways of evading them by under-reporting their catches. A central problem is the fishermen's belief that limiting their fishing effort cannot improve the state of the stock because the main cause of stock depletion does not lie with them but with their neighbours (the French and the Spaniards for British fishermen, the Spaniards and the British for French fishermen) or with external sea-roaming operators.

Poor understanding of interactions between human behaviour and the environment may sometimes characterise users of other resources than fish and game. Thus, for example, in the Kgatleng district of southeastern Botswana, privatisation of grazing lands through private ownership of boreholes did not have the effect of preventing overgrazing. Tswana people were eager to maintain or expand their cattle herds and "they continued to consider that the cause of overgrazing was the lack of rain, which forced concentration of cattle around scarce water." (Peters, 1994: 82). The solution for them lay in the digging of new boreholes and not in the enforcement of stock limits such as could be achieved through the spacing of water points. It is therefore not surprising that "most ranches have had no better record in herd and range management than the typical cattle-post system –and sometimes the record has been worse" (ibidem: 220). To take yet another example, present overgrazing in Mexican pastoral *ejidos* has been partly blamed on the *ejidatorios'* limited technical understanding "regarding the

[29] There is no denying that industrial fishing can wreak havoc in maritime fisheries as the history of recent decades amply testifies across the world. Yet, small-scale fishermen often take too much comfort from this fact to conceal from themselves the painful truth that they can also have their share of the blame owing to the rapid expansion of the artisanal fishing fleet and the tremendous improvements in the artisanal fishing technology. The same can be said of the accusations by Kayar's fishermen that migrant operators from Saint-Louis must bear serious responsibility for destruction of the fish stock under the dubious pretext that the dead fish trapped in their bottom-set nets tend to frighten the living fish out of the area (a statement that does not stand scientific scrutiny).

complex interdependence of individual grazing decisions and the impact these choices have on the range resource and, ultimately, on livestock productivity and human welfare". In particular, "local understanding of elementary soil-water-plant-animal relationships is rudimentary" (Wilson and Thompson, 1993: 314; see also Cernea, 1989: 61, for forestry)[30]. The same problem is sometimes noted also for village forests (Ribot, 1999: 32).

A final remark is in order. The absence of any measure or scheme intended for the conservation of the resource does not imply that no collective action is undertaken to regulate its use. In point of fact, rules solving assignment problems are often adopted whenever an excessive number of claims are laid to the flow product of a resource. This is especially evident in the case of fishing where rotation of fishermen around various fishing spots is frequently practiced to reduce the opportunities for conflicts that inevitably arise when the most productive resource sites are congested (see the illustration provided in Box 3 in Part 1 above, and Berkes, 1986 ; Cordell and McKean, 1986 ; Levieil, 1987 ; Hannesson, 1988 ; Baland and Platteau, 1996 : 208 ; Platteau and Seki, 2000). In a study based on thirty case studies of fisheries, Schlager has thus found that the existence of assignment externalities is significantly related to whether or not fishermen have adopted systematic procedures for fishing operations (Schlager, 1990, 1994).

Because assignment schemes are designed to solve pressing and incontrovertible problems of congestion, –if nothing is done, high transaction costs have to be incurred and grave conflicts can erupt–, and because their effects are generally clear and predictable, they are often adopted by resource users (see, e.g., Guha, 1985 ; Arnold and Campbell, 1986 ; McKean, 1986, for forestries ; Lawry, 1989a, for grazing activities ; and Messerschmidt, 1986 ; Ostrom, 1992 ; Tang, 1992 ; Mahdi, 1986, for irrigation water). Hence, a group of users able to regulate access to a resource not only by laying down membership rules defining rightsholders but also by fixing up rules governing access of members to various portions of

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[30] This said, one should be wary of inferring actual beliefs of people from their explicit statements. In point of fact, we cannot rule out the possibility that respondents strategically conceal their true beliefs about the resource stock and the impact of their behaviour on it. By feigning to believe that the resource is abundant, they self-justify their opportunistic behaviour and their reluctance to give it up. Unfortunately, it is extremely difficult empirically to uncover the true beliefs of people since they may not be easily revealed by observation of their actual behaviour and the recording of their professed opinions.

the resource domain may well be unwilling, or unaware of the necessity, to take up management measures designed for a better conservation of the resource.

As we have explained, fishing is an activity that fits in especially well with the above configuration (assignment rules but no management rules). Canal irrigation water also falls in the same category, yet for another reason : if access to water involves pervasive congestion problems, water is generally not liable to be depleted or overexploited as a result of irrigators' actions so that there is no need to take up conservation measures (the total quantity of water available to a group of irrigators is exogenously fixed for the season depending on rainfall and behaviour of the global irrigation system). From that point of view, canal irrigation water narrowly resembles beachseine fishing, a technique that has no destructive potential because the nets are operated from the beach and for which the existence of fishing turns is often observed (see, in particular, Alexander, 1980, 1982; Amarasinghe, 1989).

18.3.1.2 The evolutionary view and learning processes

Even if we adhere to the evolutionary view that the ability to collectively organise develops gradually as a response to emerging needs, a transition problem clearly remains. Indeed, nothing ensures that the resource will not be degraded during the time span required for the users to realize the main causes of the disaster and to organize themselves. As pointed out by the authors of a World Bank study:

> "Rural people deplete their forest and soil capital, often unaware that they are destroying their future source of fuel, fodder, and soil protection. The people do not realize the danger until the local forest is nearly gone and they must go farther into the countryside to find fuelwood. When the stock is eventually used up, ... the extent of the crisis becomes evident ... There is no 'fast fix' when this happens ... Deforestation by local people using wood for local uses can be a slow and largely unnoticed process ; realization of the damage may come too late for them to do anything about it without significant outside intervention" [Gregersen, Draper, and Elz, 1989: 9,144].

If the resource can nevertheless be replenished, then the evolutionary argument may just be reformulated by saying that a society needs to be confronted by a natural disaster before being able not only to realise the extent of the problem but also to organise itself so as to avoid its repetition in the future. Thus, a recent survey of more than 70 empirical studies has concluded that the normal pattern is for erosion and grazing degradation at first to worsen as population numbers and cropping frequencies rise (Templeton and Scherr, 1999). It is only at a later stage that new forms of land management designed to offset these trends and to raise land productivity are eventually induced. In the meantime, population densities have increased quite significantly, from 25 to 100 inhabitants per square kilometer on an average.

According to McKean (1986) also, it is only under the most acute pressure that Japanese villagers were driven in the Tokugawa period to adopt management measures to protect their natural resources from destruction (see Box 1 in Part 1, and, for more details, McKean, 1986 : 558). In the 17th century, this pressure took the form of a genuine ecological crisis manifested in considerable deforestation following a sudden surge in the demand for timber caused by the rapid construction of cities and castles after the return of peace conditions (during the 16th century the country had been devastated by a widespread civil war). In the author's own words:

> "For our purposes, the significance of this episode of deforestation during the 17th century is threefold: 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 regulations for the conservation of forests and the use of all commons" (McKean, 1986: 549).

It is particularly interesting to note that, in response to this visible experience of deforestation, Japanese villages have chosen not only to adopt strict conservation measures but also to regulate access to common lands in such a way as to discourage population growth. Equal rights of access to communal resources were allotted on a household basis so as to avoid giving advantages to large families and thus discourage population growth. To make this system effective, the formation of a branch household from the main family was subject to approval by village authorities. The latter "recognised that creating an additional household would enlarge the number of claimants on the commons without enlarging the commons" and were therefore reluctant to grant such a permission. In some villages, "no new household were permitted unless an old one died out for lack of heirs" (McKean, 1986: 551-53).

The same idea that learning is a time-consuming and hazardous process that may need a disastrous experience to be triggered off comes out of the study of Brightman on the ecological attitudes and practices among Boreal Forest Algonquians (1987). In this study, we are being told that, following intensified predation, limited-access land tenure and conservation eventually appeared as adjustments to depleted environments. Conservation was actually "a postcontact innovation that did not develop on any scale prior to game depletions in the early 1800s ..." (Brightman, 1987: 12). Among the *Crees* and other groups, continuous and visible experiences of game shortages slowly led Algonquians to question their traditional beliefs and, after a certain point, to reinterpret them in a way more consistent with the changed circumstances. In the words of Brightman, "*Crees* encountered in the game shortages a contradiction of cosmic proportions: despite conventional ritual treatment, animals were not renewing themselves but were disappearing". Game shortages therefore "motivated a reinterpretation of indiscriminate or 'wasteful' hunting and trapping as offensive to animals and to the spirit entities regulating each species". These spirit entities were now imagined to interfere with the harvests of hunters who trapped unselectively and conservation was redefined as a religious obligation the violation of which caused severe punishment in the form of game shortages (ibidem: 136-39).

The same lack of, or delayed, awareness accounts for the oft-noted difficulty in establishing village woodlots in rural communities whose tradition has been long centered on the priority of (communal) pasturage. In some of these communities woodlots are established in the face of considerable opposition which can occasionally lead to the purposeful destruction of fencing and of young trees, but will most commonly manifest itself in the current damages caused by "individual stock owners and herdboys seeking grazing for their animals and unimpressed by the need to protect the woodlot" (Bruce, 1986: 116 ; in the same vein, see Arnold and Campbell, 1986: 429-30; Cernea, 1989: 30 ; see also Cernea, 1985).

Probably the main lesson from the above illustrations is that villagers' awareness about the real causes behind the degradation of their environmental resources needs to be propped up especially when environmental change is rapid owing to fast population growth and accelerated processes of market integration. This can be done through the work of external agents who help villagers to articulate their traditional knowledge about their local resources with the occurring changes.

### 18.3.2 The state as a major actor

There are two major ways in which the state can impede village-level management of common property resources. The first is by abstaining from providing services, such as technical expertise, conflict-resolution mechanisms and legal support, that villagers need to be effective managers of their local resources while the second is by the way of interventions, deliberate or not, that have the effect of undermining their ability or willingness to cooperate towards that purpose. In many notable cases, these two aspects cannot be easily disentangled because they are just different manifestations of a policy that is actually opposed to local management of natural resources. Let us now look in more detail at the ways through which the state has contributed to stifle local initiatives in matters of resource management by citing a number of illustrative examples. The evidence is presented in two separate subsections, one devoted to the top-down approach to village-level resource management and the other to state interventions and policies geared toward supporting private business interests.

### 18.5.1 A top-down approach to village-level resource management

States can obviously have different views about the role of user communities in owning and managing local natural resources. At one extreme, a state can decide to give maximum empowerment to user communities by passing legislation specifically designed to support common-property systems. For example, in Japan the legal sanctioning and the constitutional guaranteeing of the property rights of fishing communities (organized as co-operative associations) over inshore waters has been an important factor underlying the success of a highly original system of decentralized management of coastal fisheries (Ruddle, 1987; Asada *et al.*, 1983; Platteau and Seki, 2000). In South Korea, Nepal and the Philippines, the law entitles village communities to generate the necessary rules, regulations and operational measures required to enforce local-level collective management of forestry and other village resources. This has implied that the state relinquishes power and responsibility to manage forests, irrigation water and fishing areas through village programmes and committees (Arnold, 2000; Pomeroy et al., 1999).

In Indonesia, the government came in support of decentralized management of coastal fisheries by granting fishermen communities exclusive tenure rights over a delimited portion of the sea. In this case, however, the motive behind the legal support of user groups was purely political: to placate mounting Islamist and nationalist opposition forces by earmarking local waters for (Muslim) Indonesian small-scale fishermen at the expense of Chinese-owned industrial vessels (Mathew, 1990; Baland and Platteau, 1996: 258-60). Given the heavy involvement of Suharto in Chinese business ventures, it is not surprising that enforcement of the exclusive fishing rights of small-scale coastal fishermen has been much less rigorous than in the case of Japan. In other words, the class-orientation of the Indonesian regime has determined a strategy which, despite appearances to the contrary, has not resulted in the devolution of *de facto* property rights to artisanal fishermen communities.

In other, much more frequent instances, state interventions have had the intended or unintended effect of destroying local capacities for collective regulation. In the case of Sahelian forests, for instance, when scarcity became apparent in the late 1960s, state-imposed rules "emasculating local organization" have hindered resource management efforts at local level. "As it happened, most villages had lost their power of independent activity as the result of efforts of both the colonial and independent regimes to establish controls over major forms of organization in rural areas. Villages (or quarters within them) had no authority to enforce sanctions against violators of locally devised use rules" (Thomson et al., 1986: 399; see also Ribot, 1999). A common pattern initiated during colonial times was to integrate village chiefs into the state as an administrative extension. This formula gave rise to ambiguity and tension due to the dual allegiances of chiefs downward to their people and upward to the central state. Chiefs in the new independent states of Africa have continued to be regarded as tools in the hands of the administration, which they actually are most of the times (Ribot, 1999: 13-14).

Rural councils which are often in charge of various management tasks regarding local resources are not necessarily more accountable to the people. In many countries, particularly in West Africa, they just do not represent the villagers but political parties and cooperatives initiated from above and effectively controlled by political and administrative machineries. In the words of Ribot: “even if rural councils were openly elected, they are not independent decison making bodies”, their official role is “merely to advise and assist the sous-préfet on political and administrative matters… they are administrative links to the central government” behaving exactly like colonial village and canton chiefs (ibidem: 18). Under these conditions, it is not surprising that village bodies officially recognised by the state are frequently politicised with all the expected corroding effects on people’s ability to organise and to manage their resources. In Senegal, for example, rural councils are at times ‘nothing more than sections of the Socialist Party’.

The above problems are characteristic not only of Africa but also of many countries in Asia and Latin America. In India, an expert scholar in irrigation issues writes, “the authority imposes a set of programmes upon the farmers which, instead of promoting their participation, actually restricts the expression of cooperation by narrowing its scope. In course of time this erodes the cooperative spirit that existed earlier” (Sengupta, 1991: 251). It is therefore not surprising that, when the state decides on water allocation and distribution, frequent rule violations are reported (Bardhan, 2000 : 15 ; see also Lam, 1998 : 175-78, regarding Nepal)[31]. The Indian experience is in stark contrast with the aforementioned experience of the Philippines where the irrigation administration systematically encourages and actually requires the formation of irrigation associations. Experimentation with diverse forms of such associative organisations is promoted by the state which disseminates knowledge about the most successful experiences. This much more interactive approach is apparently rooted in a well-established tradition that dates back to the Spanish colonial era

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[31] Thus, Wai Fung Lam writes that in Nepal, unfortunately, “enhancing farmers’ participation is frequently interpreted as an exercise of tutelage by irrigation officials to tell farmers what to do and how to fit their effort in the Operations and Maintenance plan laid down by the officials” (Lam, 1998 : 186-87). It is therefore not surprising that farmers have difficulties in perceiving water committees set up at the initiative of the Department of Irrigation as ‘their’ organizations. Rather, they tend to view them as the ‘administrative arm’ of that department (ibidem : 208).

(Sengupta, 1991: 38-54). In the words of Sengupta again: “There is no difference between irrigators in the Philippines and those in India or elsewhere as far as their readiness to cooperate is concerned. It is the technocratic distrust for people’s capabilities which prevents effective intervention” (ibidem: 80).

Note carefullly that there are at least two distinct forms taken by demoralisation or lack of motivation among villagers when the state or political authorities intrude too much in their own internal affairs instead of supporting their own initiatives with technical expertise and legal backing. First, villagers do not consider rural councils manipulated from above as legitimate bodies that represent them and, as a result, they oppose the decisions and choices made with every means at their disposal. Moreover, politicisation of these councils may easily increase tensions between various village factions if they are allied with different political parties as a result of which common property management will be more difficult (Singh, 1994: 215-16). Second, they form an expectation that the state will in any event perform the management tasks required or pay for failures if they arise. Consequently, they tend to shun participating in village schemes and programmes. In Nepal, for example, entrepreneurial energy in the irrigators’ communities tends to be directed toward getting money or construction contracts from the specialised government agency instead of organizing operation and maintenance among the irrigators themselves. Indeed, when external government funding for construction and maintenance is made available to a community, the members soon develop an expectation that repairs and maintenance jobs will be done by the state (Tang, 1992: 135; see also Arnold and Campbell, 1986: 430; Azhar, 1993: 117-18; Bromley and Chapagain, 1984: 872; Agarwal and Narain, 1989: 13, 27; Lam, 1998: 181, 193).

### 18.5.2 Active collusion with private business interests

Collusion with private business interests at the expense of commoners may manifest itself under the form of macro-economic policies biased in favour of the former. This happens, for example, when the government heavily subsidizes the intrusion into traditional resource territories of private companies. Thus, in Brazil, the exemption from taxation of virtually all agricultural income combined with the rule that logging is regarded as proof of land occupancy has strongly encouraged rich people to acquire forest lands for the purposes of maximum exploitation (Mahar, 1988; Binswanger, 1991; Barraclough and Ghimire, 1995: Chap. 3). Not only deforestation but also dispossession or disfranchisement of traditional user communities have resulted from this ill-conceived policy. Subsidization of imported trawler boats in many Asian countries constitutes another striking example of a government-supported thoughtless acceleration of the rate of exploitation of a commons which ended up disfranchising small-scale fishermen and crew labourers (Kurien, 1978, for Kerala in South India).

Active support of business ventures by governmental agencies generally placed under the thumb of high-level political authorities may be motivated by the latter's direct interests in these ventures or by their desire to oblige political supporters and friends following a logic of patronage politics. In Botswana, both motivations are at work behind the state's support given to the wealthy cattle elite for the *de facto* privatisation of grazing lands and the concomitant erosion of a traditional institution (the *kgotla*) charged with their management. In the words of Peters:

> "There is no doubt that some of the highly placed members of the government and party who promote the policy benefit directly as wealthy cattle and borehole owners. In addition, the government's apparent blindness to criticism in calling for expansion of the policy is partially driven by political considerations. Much of the strongest support for the ruling Botswana Democratic Party comes from the wealthier cattle owners. The resistance of government to consider either increasing taxation of cattle owners (a point of contention with the World Bank) or the abolition of dual rights seems attributable to fear of jeopardizing this support" (Peters, 1994: 22).

Governmental support of powerful business interests intermingled with state agencies can take on much more direct and brutal forms as illustrated by the following examples. In the Philippines, the now defunct government agency Panamin (Presidential Assistance to National Minorities), which was officially set up for the purpose of protecting the indigenous people's rights and interests, actually played a disastrous role amouting to sheer betrayal of its mission: "far from preventing the pillage of indigenous lands by mining companies, loggers and hydropower projects, Panamin collaborated with the armed forces in depriving the peoples of their ancestral lands" (Colchester, 1994: 74). The fact of the matter is that the majority of this agency's board members "came from wealthy industrialist families, many of whom had direct financial interests in companies encroaching on indigenous lands". This was certainly the case for Manuel Elizalde, a relative of President Marcos, who played the key role in Panamin. His political base and personal wealth, indeed, lay in extractive concerns such as mining, logging and agribusiness. Moreover, he maintained his own private army in Cotobato in Mindanao to fight the insurgent indigenous peoples who, in despair, took up arms against the government by joining the communist insurgency group (ibidem: 75).

In East Kalimantan's forests, Indonesia, customary rights-holders have been unfairly deprived of access to village commons as a result of licensing rights awarded to private companies. In the early 1970s, the Indonesian government thus granted timber concessions to a large number of foreign and national companies, and, according to Jessup and Peluso, this had several detrimental effects on local communities. In particular, "despite their legal right to collect minor forest products within timber concessions, villagers have at times been denied entry to those areas, and timber company personnel have otherwise infringed on the rights of local residents". For instance, there is evidence of timber company guards confiscating *rattan* from collectors, of loggers raiding caves and selling the stolen birds' nests to unauthorised buyers, and of timber companies illegally cutting Borneo ironwood, a species reserved for local use, acts which sometimes led to violent confrontations between local inhabitants and company guards or loggers (Jessup and Peluso, 1986: 520-21).

In Sarawak, Malaysia, forest-dwellers feel equally helpless even though the process of dispossession has been less brutal and open than in Mindanao. We are thus told that "the corrupting influence of the timber trade has promoted the domination of the economy by nepotistic, patronage politics", with the consequence that rural peoples "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 millionaires". (Colchester, 1994: 79, 82). In such circumstances, it is not surprising that most popular protest movements in Asian forest areas have directed their main criticism at the logging licenses generously distributed by too often corrupt governments.

In lending support to rural elites and powerful urban interests (including its own high-ranking personnel) to help them gain access to valuable natural resources, national states may have recourse to various legal subterfuges. An oft-used method, already applied by the colonial powers to redistribute indigenous lands in favour of white settlers, consists of withdrawing lands from village control by labelling them state property and later awarding them to friends of the regime through de-classifying procedures. Such a method, for example, is currently employed by the Senegalese state in the case of the lands of the Senegal river valley, much to the fury of helpless customary rights-holders.

## Part 4 Conclusions

### 18.4.1 Incentive systems, decentralization and co-management

Nowadays, as a response to the numerous excesses of centralisation and the ensuing financial crises of specialised administrations, devolution of the management of local resources from state agencies to rural communities is being tried in an increasing number of countries with the active support of bilateral and multilateral donor agencies. It is still too early to have a sound idea about how these programmes of decentralised development can perform and how the above-discussed perverse mechanisms are being surmounted. The step is no doubt in the good direction, yet empowerment of village communities is likely to be a much more difficult task than what many imagine, partly because of the bad habits developed in the past, of the likely resistance of state agents whose responsibilities are going to be encroached upon, and of the inherent difficulties of collective action in resource management matters as underlined in the previous sections.[32] Even in a country like the Philippines where the national irrigation administration has been pioneering efforts of devolution, it appears that there have been more cases of failure than success, and reduction in state agencies' operation and maintenance activities has not been compensated for by the activities of irrigators' associations with alarming consequences for agricultural production (Fujita et al., 1999 : 3 ; see also Lam, 1998, for Nepal). There is therefore an acute need to critically assess ongoing experiences with sound research methodologies.

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[32] For a thorough discussion of the limitations of participatory approaches to development arising from community imperfections, see Abraham and Platteau (2001).

The challenge ahead lies mainly in finding the right kind of incentives so that both user groups and state agents work effectively and in a coordinated manner to ensure proper conservation of village resource bases. A few examples can illustrate what we have in mind. To begin with, if the state does not legally support the actions of user communities by granting them clear and enforceable property rights over the common-property resource, they will have no incentive to guard it against encroachments by external intruders. Marine fishermen communities are thus discouraged when they realise that their efforts to catch industrial vessels found trespassing their fishing territories are in vain because the culprits are released as soon as they are landed or are not required to pay the required fines to the authorities (perhaps because the latter are stakeholders in the business ventures involved). The same problem is often mentioned in connection with protection of village forests or irrigation systems (see, e.g., Sengupta, 1991 : 136). The need for user organisations to be free from government and political pressure obeys the same logic of providing them with effective incentives to monitor their resource domain.

The second example is specific to large-scale irrigation systems built by the state. Here, the problem is for the latter to ensure that user communities will carry out complementary works and maintenance operations in a reliable manner. This may happen or not depending on whether the central irrigation administration has devised an appropriate incentive mechanism. Such was not the case, obviously, with the Jamua Irrigation Project in India. Started in 1965 to tap the Jamua River by constructing diversion works and extending the canal network on its left bank, it was able to reach hardly more than 30 % of the target area by 1974. The cause of the failure came from the unjustified assumption on the part of the authorities that "once the canal system was constructed, farmers would willingly and jointly contribute their own labor to construct field channels to divert waters from the canal to their field". What they thus overlooked was that "farmers located near the canal would have little incentive to devote their efforts to constructing channels that would deliver water through their own fields into those of others" (Tang, 1992 : 133). Here is a delicate problem of imperfect commitment arising from asset specificity that has not been properly perceived by the irrigation department.

In the same vein, sophisticated irrigation technologies involving permanent headworks may run against the interests of downstream farmers because they have the effect of reducing drastically the amount of labour needed for operations and maintenance of the system. As a consequence, the labour contribution of these farmers becomes less critical for the farmers at the head end who can thus afford to ignore the demands for a fair share of the available water by the former (Ostrom and Gardner, 1993 ; Lam, 1998 : 119-124, 202-203). In other words, by transforming the game from one in which everyone's participation in collective action is required into one in which the participation of only some of the users is sufficient, technological change can lead to a situation where irrigation water becomes appropriated by the owners of strategically located lands.

On the other hand, intervening state agents must also be motivated to perform effectively for the benefit of resource users in circumstances where the latter are no more considered as passive subjects. In South Korea, farmers have been integrated at the bottom of the formal management hierarchy itself, in the role of patroller. The land of a patroller must lie within the jurisdiction which he irrigates, "so that he experiences irrigation problems at first hand". Moreover, he is nominated each year by the headmen of the villages within his service area and, if the latter are dissatisfied with his way of handling the task, they nominate someone else. Recruitment and promotion procedures also play an important role inasmuch as they ensure that the senior-level staff are natives of the area in which they work. "Hence the eyes of the irrigation staff are kept firmly on the locality, and identification between their interests and those of farmers is further encouraged" (Wade, 1988b: 495). Elaborating on this theme, Wade adds:

> "Local affiliation of the staff is important because it gives both sides - staff and farmers - a set of shared experiences. This directly assists a sense of mutual obligation between them; and also provides a basis for a shared set of beliefs according to which the existing order is fair and just, and every betrayal is perverse and unjust - including betrayal of the irrigation agency's rules. This is a much more cost-effective method of avoiding free-rider problems than relying on a calculus of punishment" (Wade, 1988b: 495).

Much the same picture emerges from the situation in Taiwan where the staff of the Irrigation Associations (IAs) are effectively linked to the local farmers, on the one hand, and to the national agencies, on the other hand. For each rotation area, an irrigation group chief is elected to supervise water distribution and maintenance operations as well as to manage potential conflicts. In particular, these chiefs are in charge of closely monitoring the jointly hired common irrigators who have primary responsibility for the distribution of water and the guarding of the system against frauds and damages. As a matter of principle, they are local farmers and, to avoid undue interference of partisan politics, the process leading to their election is kept separate from elections for other offices. In addition, the irrigation staff themselves are typically recruited from local communities so as to ensure adequate incentives for effective management of the system. In the words of Moore:

> "The IAs are overwhelmingly staffed by people who were born in the locality, have lived there all their lives, and in many cases farm there. Further, IA staff are not sharply differentiated from their members in terms of education or income levels. I have a strong overall impression that IA staff are so much part of local society that they can neither easily escape uncomfortable censure if they are conspicuously seen to be performing poorly at their work, nor ignore representations made to them by members in the context of regular and frequent social interactions" (Moore, 1989: 1742).

In addition, performances in collecting irrigation fees are an element that enters into the annual evaluation of irrigation officers by their superiors and that indirectly determines salary increases, promotions, and access to additional resources. Each level of the irrigation bureaucracy is thus required at regular intervals to report its collection records to the upper level (Moore, 1989 : 1743).

Clearly, the above-described mechanisms ensure a good deal of accountability of officials to resource users, which is a critical condition for success in local-level resource management. It is particularly important to control the widespread corrupt practices whereby private contractors are required to pay a certain amount of so-called commissions to officials in order to get a construction or maintenance contract. This forces the contractors to cut expenses by using poor quality, or smaller amounts of, materials in the commissioned works. Since they have taken an illegal commission, the officials are not likely to monitor the quality of these works as they should and low-quality infrastructure is produced. As a result, resource users are discouraged from supplying effort towards maintaining it properly, both because the incomes derived from its functioning are disappointingly low and because maintaining a poor quality or ill-designed infrastructure is difficult. This sort of problems have been especially emphasized with respect to management of irrigation systems (see, e.g., Wade, 1982 ; Lam, 1998 : 179-81). Note that resistance against decentralization and democratization efforts in irrigation administrations is partly due to the fear among irrigation staff that they would end the profitable opportunities for illegal profit that the present system allows (Lam, 1998 : 196).

**18.4.2 Summary of the main points**

This paper calls into question the romantic view according to which small and homogeneous village communities are able on their own to devise rules aimed at the efficient management of their common property resources.

We have first argued that rules devised by communities, wherever they exist, do not necessarily aim to improve the efficiency of use of the resource, but often serve the purpose of regulating (or organising) access to the resource domain under congested conditions, preventing conflicts, or enhancing the users' market power. In many cases, and contrary to a dominant interpretation in the empirical literature, distributive considerations appear to play a more important role than efficiency considerations in traditional management practices at village level.

Second, it is generally assumed that at local level users have a clear perception of the impact of their behaviour on the state of the resource. Careful case studies however suggest that this may not be the case, especially with regard to resources that occupy wide territories, are mobile and not permanently visible, such as game or fish resources.

Third, small size and homogeneity do not necessarily facilitate collective management of natural resources. We have thus reviewed a number of analytical arguments and case study materials in which the presence of large, highly motivated agents, or the large size of the user group, promote rather than hinder the efficient management of village-level resources. In particular, we find that inequality is more likely to encourage efficient use of common property resource when it facilitates the establishment of a regulatory authority, and in appropriation problems, when increased inequality reduces the aggregate level of use of the resource, by placing constraints on the individual harvesting efforts of the smaller users. By contrast, when the gamut of available regulatory instruments is limited, inequality between users makes collective agreement and effective enforcement of regulatory schemes more difficult to achieve. In games of voluntary contributions to a common good, the impact of inequality is more ambiguous: while it is generally true that larger users tend to contribute more to the common good, increased inequality also reduces the incentives of small users to contribute.

Lastly, the support of the state is often required to help communities manage their resources. It can thus play a crucial role in disseminating information about the state of the resources, the relationships between harvesting practices and the stock, and the best management practices available; in imparting skills and administrative capacities needed at the village level; in enforcing community-based property rights; in performing as a last resort mediator in the event of serious conflicts over resources; etc. Unfortunately, well-documented experiences of the recent decades show that most state interventions have been motivated by the pursuit of private interests that are not compatible with an effective support to community-based management. For the success of a co-management approach, it is therefore essential to design and implement appropriate institutional mechanisms that give maximum incentives to both state agents and village communities to act in a way that helps preserve resources in the long term to the greatest benefit of local users. This is a considerable challenge that will necessitate many experiments before it can be effectively met.

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**Appendix: The endogeneity problem in collective action studies**

Let us start by describing the model implicitly or explicitly tested by most authors whether they actually use quantitative data or rely on discursive discussions based on qualitative information. Once this is done, we will turn to a critique of the underlying empirical approach. The observation unit is the group of users and the explanandum is the probability that they will collective organise with a view to regulating access to, and use of, a natural resource or, alternatively, the extent of collective regulation achieved among them. This dependent variable can be hypothesised to depend on the net relative profitability of collective regulation compared to other available institutional arrangements. Any equation attempting to explain success of common property regulation must therefore comprise explanatory variables that bear upon the gross benefits arising from such regulation, the costs involved, and the net benefits achievable under an alternative mode of ownership. The following equation meets such a requirement:

$$Y = Y(Gains, Costs, Altern), \qquad (1)$$

where *Y* stands either for the institutional form understood as the extent of collective regulation achieved (or, equivalently, the probability that a set of users collectively regulate the use of a natural resource), or for the degree of effectiveness of collective regulation (i.e., the net gains resulting therefrom) as measured by various performance criteria (incidence of conflicts over use of the resource, incidence of rule conformance, quality of maintenance of the collective infrastructure required for appropriating resource flows, the extent of resource overexploitation, etc.). *Gains* measure the gross benefits achievable with common property regulation; and *Altern* refers to the net gains obtainable under an alternative mode of regulation and ownership, private property or state management and ownership, in particular. The expected gross benefits from collective regulation depend on the attributes of the resource system and the characteristics of the harvesting technology, designated by *Techres,* as well as on other determinants designated by $Z^{gains}$. For example, it is evident that farmers have not much to gain from coordinating their irrigation efforts if the topography of the service area is unfavourable, or if the basic infrastructure has been poorly devised (see, e.g., Chambers, 1988; Sengupta, 1991). We can therefore write[33]:

$$Gains = G(Techres, Z^{gains}), \qquad (2)$$

On the other hand, the governance costs that common property management entails are influenced by the characteristics of the resource users (in terms of numbers, homogeneity, mobility, previous experiences in community organisation, etc) denoted by *User,* the aforementioned variable *Techres,* and the official policy and public actions regarding decentralised group initiatives, denoted by *State*. In the following pages, we will have ample opportunities to illustrate these various effects so that there is no need to elaborate on them at this stage. Formally, we have:

$$Costs = C(User, Techres, State) \qquad (3)$$

Substituting (2) and (3) into (1), we get the following reduced-form equation:

$$Y = Y(Techres, User, State, Altern, Z^{gains}) \qquad (4)$$

Such is the canonical equation considered in most empirical studies dealing with common property management by user communities. In these studies, the dependent variable is typically defined in terms of performance criteria (see supra). The model depicted by equation (4) actually suffers from a major flaw, namely the fact that it overlooks the endogeneity relationships between the organisational form, the expected gains, and the user characteristics. It is indeed difficult to deny that at least some important characteristics of the resource users are not given parameters but variables over which the users themselves have some degree of control. More particularly, they may want to modify their own profile and organisation so as to make them more conducive to a collective mode of regulation. For

[33] We assume that user characteristics influence net gains through costs rather than through gross benefits

example, villagers may control the size of user groups (Wilson and Thompson, 1993: 300-12)[34], or reduce the heterogeneity of group membership along various dimensions such as caste or class composition, wealth, length of residence, location of landholdings, etc (Sengupta, 1991: 114, 119, 128, 167, 189, 192).

In an analogous manner, it can be argued that users may be able to change some attributes of their resource system or some characteristics of their harvesting technology. This is particularly evident in the case of small-scale irrigation systems, such as storage tanks fed by diversion channels in watershed areas, that can be locally designed according to user-friendly criteria (Sengupta, 1991, 1993; Chambers, 1988). In order to avoid confusion and to keep our notation as simple as possible, we assume that the variable *Techres* comprises only attributes and characteristics that are not susceptible of being altered by users. As for those that are susceptible of such alteration, they are subsumed in the *User* variable.

Thus, the variables *Y, Gains,* and *User* are endogenous to each other and, as a result, they are simultaneously determined by the user group considered. Analytically, the problem of the user group can be represented as that of maximising expected net benefits by choosing both the appropriate organisational form and the appropriate user characteristics (to the extent that they are manipulable). In formal terms, defining $x$ as a particular institutional form belonging to the set $X$ (itself a subset of $Y$, since $Y$ can also be taken to mean the performance of collective regulation), we have:

$$\max_{\substack{x \in X \\ u \in U}} Netgains = G(x, Techres, Z^{gains}) - C(x, u, Techres, State) \qquad (5)$$

so that

$$x^* = \arg\max_{x \in X} Netgains(u^*, Techres, State, Z^{gains})$$
$$u^* = \arg\max_{u \in U} Netgains(x^*, Techres, State, Z^{gains})$$

[34] In their example, liberalisation of the *ejidos*'s rules by the Mexican government led members to form grazing coalitions within smaller groups based upon the extended family.

where the star upperscript indicates that the value of the variable is the equilibrium value. Note that the variable *Altern* does not figure out in the above formulation since it is subsumed under the maximisation process.

Econometrically, we therefore have a system of three equations to estimate and, owing to the presence of endogeneity, they need to be instrumented for. These three equations are:

$$X = X(User, Gains, Techres, State, Altern, Z^{gains}, R, \varepsilon) \quad (6)$$

$$Gains = G(X, User, Techres, State, Altern, Z^{gains}, S, \eta) \quad (7)$$

$$User = U(X, Gains, Techres, State, Altern, Z^{gains}, T, \mu), \quad (8)$$

where *R, S,* and *T* are exogenous variables, and $\varepsilon$, $\eta$, and $\mu$ random terms, specific to equations (6), (7), and (8), respectively. Estimating the system (6)-(8) is obviously more tricky than estimating equation (4), yet it is the only way to ensure that observed facts or relationships are correctly interpreted. In particular, it is essential to measure the effects of user characteristics on collective regulation after having duly controlled for the possible impact of prospective benefits and the organisational form on these characteristics.

Consider the following conclusive statement about the determinants of the relative performances of a large number of irrigation systems located in several (mostly Asian) countries: "Community irrigation systems are likely to be developed and sustained in situations with a reasonable supply of water, no major social cleavages, and low-to-moderate income variance among irrigators. A majority of the bureaucratic cases, on the other hand, are characterized by inadequate supplies of water. Many of them are also characterized by major social cleavages and high income variance" (Tang, 1992: 124). How can we be sure that the state of water supply (a peculiar specification of the *Gain* variable) is not endogenous to the institutional arrangement adopted, rather than being an exogenous condition influencing institutional choice? When the effect of water scarcity is mixed up with that of possible bureaucratic inefficiencies in release of canal water (bureaucratic irrigation systems are always associated with canal irrigation), no definite answer can be provided to that crucial question[35].

[35] This difficulty has been explicitly mentioned, but not really tackled, in Bardhan (2000).

The same problem arises in connection with the user characteristics mentioned, namely social and economic heterogeneity: to what extent is it a given parameter of the institutional choice problem and to what extent an endogenous outcome produced by the operation of the regulatory mode chosen ? Thus, for example, collective regulation of irrigation water may involve the scattering of landholdings (particularly those of the economic elite) over the head, tail and middle of the service area so as to ensure effective maintenance of the entire system and even distribution of water throughout (Coward, 1979; Sengupta, 1991: 110-11, 120, 167, 189, 192, 266; Quiggin, 1993: 1130). In so far as this practice forces the big landholders to attend to all parts of the system including the tail end locations where the poor are likely to have their unique parcel, it may be expected to reduce the effect of inequality in landholdings on income distribution. If the latter is considered as the proper measure of inequality, it is endogenous.

The central difficulty with the estimation of the system (6)-(8) above is of course that intrumentation is bound to be difficult. It is indeed hard to find variables that, for example, influence expected benefits while leaving user characteristics and the organisational form unaffected. This task is even likely to be insurmountable if the sample of resource systems and user groups is large as it is supposed to be in cross-section studies. There remains the solution of estimating a reduced-form equation expressing $X$ as a function of exogenous variables only. Unfortunately, as we know, results thereby obtained do not lend themselves to unambiguous interpretations since they are the outcome of the combined effects of the exogenous variable concerned and all the endogenous variables operating in a hidden way behind the estimated equation.