The Mahesh Chandra Regmi Lecture 2010

INSTITUTIONS AND RESOURCES

Elinor Ostrom

7 DECEMBER 2010

SOCIAL SCIENCE BAHA

KATHMANDU, NEPAL

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सोशल साइन्स बहाः
SOCIAL SCIENCE BAHA

Himal Books

This is the full text of the Mahesh Chandra Lecture 2010 delivered by Elinor Ostrom on 7 December 2010, at The Shankar Hotel in Kathmandu.

The Social Science Baha gratefully acknowledges the support of The Asia Foundation and Alliance for Social Dialogue in making the lecture and its publication possible.

ISBN: 978 99933 43 98 1

Back cover show Mahesh Chandra Regmi in the audience at the inaugural lecture on 24 April, 2003. Photograph by Bikas Rauniar.

Published for Social Science Baha by Himal Books

Social Science Baha
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Himal Books
Himal Kitab Pvt. Ltd.
Regd. office:
Tridevi Marg, Thamel, Kathmandu
Sales outlet:
Patan Dhoka, Lalitpur, Nepal
Tel: +977-1-5542544/2120321 • Fax: 5541196
info@himalbooks.com • www.himalbooks.com

Printed in Nepal

Many important environmental goods for our joint future are common-pool resources, which will be the focus for this lecture. *Common-pool resources* include resources that are sufficiently large that excluding potential beneficiaries from using them for consumptive or nonconsumptive purposes is nontrivial. Each individual consumptive use (e.g., harvesting a truckload of forest products or withdrawing water from an irrigation system) reduces the resource units that are available to others (V. Ostrom and E. Ostrom 1977; Ostrom, Gardner, and Walker 1994). Without effective institutions to limit who can use diverse harvesting practices, highly valued, common-pool resources are overharvested and destroyed (Myers and Worm 2003; Mullon, Freon, and Cury 2005; FAO 2005).

In this lecture, the term *institutions* refers to the *rules* that humans use when interacting within a wide variety of repetitive and structured situations at multiple levels of analysis (North 2005; Ostrom 2005). Individuals who regularly interact use rules (or the absence of rules) designated by government authorities as relevant for situations of a particular type. They may also develop and enforce

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It is a great honor to be asked to give the Mahesh Chandra Regmi Lecture. In this paper, I have drawn on research on institutions and natural resources conducted over the last five decades. In addition to new work, I have drawn on several earlier papers and I appreciate the support for the research on which this lecture is based that has been provided by the National Science Foundation, the Ford Foundation, and the MacArthur Foundation. Many colleagues at the Workshop in Political Theory and Policy Analysis at Indiana University have contributed to this research through the years as well as colleagues in Nepal and India with whom I have had the privilege to work.

their own rules. Individuals interacting within a particular rule-structured situation linked to a specific environment may also adopt norms regarding their behavior given the others who are involved and their actions over time. In light of the rules, and shared norms when relevant, individuals adopt strategies leading to consequences for themselves and for others (Crawford and Ostrom 1995). As individuals learn more about the outcome of their own and other's actions within a particular situation, they may change norms and strategies, leading to better or worse outcomes for themselves and the relevant environment.

Open-Access Problems

One of the earliest, most powerful, and long-lasting models of a common-pool resource is the static model of a fishery published by Scott Gordon in 1954. In an open-access fishery, Gordon (and many other scholars who have drawn extensively on his work) posited that each fisher would invest effort in harvesting until they reached an equilibrium where individual revenue equaled their cost. Achieving this individually profitable level of harvesting, however, wastes substantial resources and threatens the long-run sustainability of the resource. More and more harvesters want to enter the resource, and eventually they can destroy it.

This static model has repeatedly been used to show why common-pool resources that generate highly valued resource units will be overharvested when no effective rules limit entry or withdrawals. The power of the Gordon model comes from the clarity of its representation of why unregulated common-pool resources are overharvested. On the other hand, its simplicity is also a weakness when used for designing new institutions to overcome economic incentives to overharvest. As Colin Clark (2006: 15) reflects, the static, 'stick-figure' model is too simplistic for analysts to apply it as if it adequately described all common-pool resources. The presumption of many analysts has been that all that is needed is for a government to impose rules so that harvesters face different incentives and withdraw at a maximum sustained yield.

Recommending Optimal Institutions

The widespread acceptance of the Gordon model led policy analysts to recommend three idealized institutions to induce individual users to engage in sustainable harvesting practices. Some of the rules recommended as 'optimal' are private property (Demsetz 1967; Raymond 2003), government ownership (Terborgh 1999, 2000; Lovejoy 2006), or community control (Vermillion and Sagardoy 1999). Multiple examples exist where moving to government ownership, private property, or community control of a common-pool resource has worked to help users achieve more efficient short-term results and potentially to sustain the resource over the long term. The particular arrangements that have proven to be effective, however, differ radically from one another and from the simple policy recommendations made by scholars recommending 'optimal' solutions (Rose 2002; Tietenberg 2002).

Government Property and Common-Pool Resources

For some scholars, public ownership of land is the *only* way to achieve sustained conservation over time (Lovejoy 2006; Terborgh 1999). This has led to proposals for creating a system of government-protected areas across the world (Ghimire and Pimbert 1997). Currently, more than 100,000 protected areas already exist and include approximately 10 percent of the forested areas in the world (Barber, Miller, and Boness 2004). While considerable enthusiasm exists for creating protected areas, their performance varies substantially.

Some positive evaluations of the effectiveness of protected areas rely on qualitative ratings by government officials and park managers at multiple sites rather than independent studies (Bruner et al. 2001; Ervin 2003). While it is important to learn what officials think about their progress, full reliance on self-assessments may introduce serious biases in the analysis (Nepstad et al. 2006; Hockings 2003). A study of forest conditions evaluated by an independent forester or ecologist for 76 government-owned protected parks as contrasted to 87 forests owned under a diversity of arrangements (private, community, government) did not find *any* statistical difference in the forest conditions between protected areas and all others (Hayes 2006; see also Gibson, Williams, and Ostrom 2005).

A large study conducted by the World Wildlife Fund (WWF) included over 200 protected areas in 27 countries. The WWF found that many protected areas lacked key financial and human resources, a sound legal basis, and did not have effective control over their boundaries (WWF 2004). Due to these conditions, extensive conflicts among park residents, park personnel, and with local communities that surround many protected areas are frequently reported as well as illegal harvesting (Wells and Brandon 1992). Nepstad et al. (2006) broadened the debate by examining several different tenure arrangements within protected areas including extractive reserves, indigenous territories, and national forests in Brazil. Under conditions of intense colonization pressures, they found that strictly protected areas are more vulnerable to deforestation and fire than indigenous reserves. These and other studies indicate the need to shift away from the presumption that creating government-owned parks and reserves is the *only* way to protect forests and biodiversity.

Carefully controlled analyses of over-time remotely sensed images of deforestation levels in national parks located in the *same* country have found that some are well protected and others were not. Ostrom and Nagendra (2006) provide strong evidence that the Mahananda Wildlife Sanctuary in West Bengal, India, has successfully prevented deforestation, but this success involves high administrative costs and considerable conflict with the local population. On the other hand, the Tadoba Andhari Tiger Reserve in Maharashtra, with only a modest budget, is not able to control entry into the forest, and the loss of forested land is substantial. Forests within Tikal National Park in the Mayan Biosphere Reserve in Guatemala—well-financed through fees collected from tourists—are in excellent condition (Dietz, Ostrom, and Stern 2003). At the same time, nearby national parks—Laguna del Tigre National Park and the Sierra del Lacondon National Park—even though they are the same ecological zone and under the same institutional structure, are ravaged by illegal harvesting.

Private Property and Common-Pool Resources

Private property is frequently recommended as 'the' way to reduce the tragedy of the commons. And, some private property systems backed up by community and government institutions have worked rather well. In Southern California after World War II, for example, groundwater producers used the California courts as an arena in which to determine who had rights to pump how much water per year. The courts also established a Watermaster to determine factual information initially needed to determine rights and then to monitor the conformance of water producers to the agreements (Blomquist 1992). In the groundwater basins that were adjudicated and rights allocated, markets for water rights emerged rapidly. Further, water rights tended to be sold or leased by those who had lower marginal productivity to those with higher marginal productivity—such as water companies who needed rights to pump water to meet peak demands—and by rights holders who were exiting the resource (either by moving away or by ceasing or changing their business) to users who wished to expand their access to local water sources.

After a half century, times have changed in regard to the population of the region, local water sources, and water availability in several linked aqueducts. The continuing jurisdiction of the California court system has enabled water producers to adjust the rules they had earlier negotiated to cope with disturbance and changing conditions (Steed and Blomquist 2006; Blomquist and Ostrom 2008). In some years, producers were authorized to take more than their assigned rights so long as they then curtailed their water production at a later time (similar to receiving a monetary loan from the bank that has to be paid back). And, in some cases, producers were authorized to take less than their assigned shares and 'bank' or store water for future withdrawal. Further, the water producers have experimented with a diversity of other institutions, such as the creation of special districts to levy a substantial tax on pumped water, to pay for basin replenishment as well as monitoring and reporting on basin conditions. Thus, while privatizing rights was a crucial step in reducing continued overharvesting of groundwater in Los Angeles, it was only one of a complex series of institutional changes and adaptations over time.

In relationship to fisheries, individual transferable quota (ITQ) systems are frequently recommended as the 'optimal' strategy for creating private property in regard to fisheries (Scott 1988; Raymond 2003). Notable cases exist where establishing an ITQ system has averted a collapse of a fishery, but few of the 'successes' were immediate. All took some time adjusting various aspects after a national government agency first designed an ITQ system. Most of the successes have evolved into more complex systems relying on multiple institutional arrangements rather than being simple ITQ systems.

The British Columbia trawl fishery for groundfish, for example, had been heavily utilized since World War II (Grafton et al. 2006). Early efforts to control overfishing by governmental policies included: restricting the number of fishing vehicles and the equipment that could be used, the assignment of Total Allowable Catch (TAC) quotas, and the assignment of fishing trip quotas. Massive overharvesting led to the closing of the fishery in 1995. Within a few years, the fishery was reopened with new regulations including an annual ITQ system granted by the Federal Minister of Fisheries for each species (Clark 2006: 238–40). Thus, fishers do not 'own' the quota assigned, but some trading is allowed, and no ITQs have been taken away from assigned trawlers. In addition, all catches are recorded by onboard observers to avoid earlier problems of underreporting. Clark (2006: 239) observed that the ITQ system has led to profound changes:

> First, catch data are now reliable, allowing the scientists to perform believable TAC estimates. (This is the result of the observer program, not of the ITQ system itself, although the latter no doubt implies a degree of acceptance and support of the observer program.)
>
> Second, a decrease in fleet capacity has occurred, as both small and large vessels have sold their quotas and withdrawn from the fishery. . .

> In terms of resource conservation, discards are not only accurately quantified, but have also been significantly reduced because of the ITQ-generated economic incentives against catching unwanted species.

Thus, the ITQ system has had a positive impact on the fishery, but an effective monitoring system was also an essential aspect of the success.

Community Property and Common-Pool Resources

While some scholars have been overly enthusiastic about the performance of diverse kinds of community ownership or involvement as a solution to overharvesting of common-pool resources (Western and Wright 1994), strong involvement of a community is an important factor in long-run sustainability, but community property is no more a panacea than private or governmental ownership (Campbell et al. 2001; Meinzen-Dick 2007; Nagendra 2007). Empirical studies of common-pool resources under community control have shown that benefits are sometimes distributed in an unequal fashion among community members (Platteau 2004; Oyono, Kouna, and Mala 2005) leading in some cases to the exclusion of the poorest members of a community (Malla 2000).

Little evidence exists that *simply* turning common-pool resources over to local users will avoid overharvesting especially if these same resources were taken away from users decades earlier and are in degraded condition when returned. Some communities manage their fisheries or forests better than others (Acheson 2003; Andersson 2004; Gibson, McKean, and Ostrom 2000). While strong evidence exists that local communities are capable of creating robust local cure-all (Berkes 2007). Some donor-funded efforts have turned control over to local residents with a simple blueprint approach (Pritchett and Woolcock 2004), leading to little community involvement and enabling local 'elite capture' of benefits. One example of successful community property for sustaining resources is the extensive number of farmer-managed irrigation systems in Nepal.

Comparing Farmer-Managed to Agency-Managed Irrigation Systems in Nepal

Farmers have survived over the centuries in much of Asia due to their evolved knowledge of how to engineer complex irrigation systems including dams, tunnels, and water diversion structures of varying size and complexity. None of these systems work well, however, without agreed-upon rules for allocating water as well as allocating responsibilities for providing the needed labor, materials, and money to build the systems in the first place and maintain them over time. Since Nepal was governed by a collection of princes until 1848, farmers built paddy rice systems through the centuries without a central government that took major responsibility for planning, building, or maintaining these systems. Even when the Rana family consolidated power in the mid-nineteenth century, very little national attention was paid to irrigation until the 1950s. In the mid-1950s, a Department of Irrigation was established and a series of Five Year Plans articulated and developed. Since then, the Asian Development Bank, the World Bank, CARE, the International Labor Organization, and other donors have invested very large sums in designing and constructing large-scale, agency-managed irrigation systems (AMIS) in some regions of Nepal.

The actual number of farmer-managed irrigation systems (FMIS) is not precisely known. The best estimate is that there were around 20,000 such systems ten years ago and that of the total irrigated land in the country, 75 percent was served only by FMIS (APP 1995). The existence of multiple systems organized in diverse ways has provided an excellent opportunity to compare the performance of systems organized by the farmers themselves as contrasted to systems designed by engineers working for a donor or a national government.

Farmers in Nepal have long exerted local authority to create their own water associations, construct and maintain their own systems, and monitor and enforce conformance to their rules (see Benjamin et al. 1994; Lam, Lee, and Ostrom 1997; Sengupta 1991; Yoder 1994). The irrigation systems constructed and maintained by farmers tend to rely on low-tech construction techniques including building nonpermanent headworks from mud, trees, and stones. International aid agencies have provided considerable funding to government agencies in an effort to upgrade the engineering standards.

Colleagues associated with the Irrigation Management Systems Study Group at the Institute of Agriculture and Animal Science, Tribhuvan University in Nepal, have been working with colleagues at Indiana University since the early 1990s (Shivakoti, Giri, and Ostrom 1992; Benjamin et al. 1994; Lam, Lee, and Ostrom 1994). We have jointly developed the Nepal Irrigation Institutions and Systems (NIIS) database that now has information about 231 irrigation systems located in 29 out of the 75 districts in Nepal (Joshi et al. 2000).[1]

Our consistent finding, and that of other scholars doing research on irrigation in Nepal (Gautam, Agrawal, and Subedi 1992), is that on average, FMIS outperform AMIS on multiple dimensions (Shivakoti and Ostrom 2002). That farmers have organized an irrigation system is the variable with the largest explanatory power of any that we have identified in the NIIS studies. Let me provide a very brief overview of our findings from this extended research.[2]

Focusing on three measures of the physical condition of the irrigation system at the time of data collection, as shown in Table 1, a larger proportion of FMIS are able to maintain the overall physical condition of the system in excellent or moderately good condition as contrasted to AMIS, as well as achieving higher technical and economic efficiency (see Lam 1998 for definitions of these concepts). The better physical condition of the canals enables FMIS to achieve increased levels of cropping intensity (the number of crops grown during a year) at both the head and tail end of a canal, as shown in Table 2. Thus, the investment of farmers in keeping their systems in good physical condition pays off in regard to significantly more agricultural productivity.

1 The findings discussed in this paper are based on data, most of which was collected in earlier, more peaceful times.

2 Readers who wish to dig deeper are encouraged to read Lam (1998), Joshi et al. (2000), and Shivakoti and Ostrom (2002) and the extensive references cited therein.

Table 1. **Relationships between governance structure and physical condition of irrigation**

Physical condition of irrigation systems		**Types of governance structure**		**Chi-square value**	**Sig.**
		FMIS(%)	**AMIS(%)**		
Physical condition	Excellent[37]	18.2	8.4	23.02	.00
	Moderately good[144]	67.4	45.8		
Technical efficiency	Poor[48]	14.4	45.8	27.30	.00
	Highly efficient[58]	28.9	12.5		
	Moderately efficient[137]	62.8	50.0		
Economic efficiency	Inefficient[33]	8.3	37.5	45.35	.00
	Highly efficient[66]	33.2	12.5		
	Moderately efficient[140]	63.5	52.1		
	Inefficient[23]	3.3	35.4		

Note: Number of irrigation systems is in brackets.
Source: Joshi et al. (2000: 78).

About two-thirds of both FMIS and AMIS have formal written rules that include provisions for imposing fines on farmers for not contributing resources to operate and manage the systems (Joshi et al. 2000: 75). On the other hand, in eight out of ten AMIS, an official guard is hired, while only six out of ten FMIS rely on an official guard (ibid.). The presence of an official guard, however, does not translate into an increased likelihood that fines will actually be imposed. On 75 percent of the FMIS, fines are actually imposed when farmers are observed to break a rule, while fines are actually imposed on only 38 percent of the AMIS (ibid.: 76). Farmers follow the rules of their

Table 2. **Relationships between governance structure and cropping intensity of irrigation systems**

Cropping intensity		Types of governance structure		Chi-square value	Sig.
		FMIS(%)	AMIS(%)		
Intensity at head end	High[142]	70.2	52.2	5.27	.02
Intensity at tail end	Low[72]	29.8	47.8	13.74	.00
	High[123]	65.1	34.1		
	Low[87]	34.9	65.9		

Note: Number of irrigation systems is in brackets.
Source: Joshi et al. (2000: 80).

system to a greater extent on FMIS than on the AMIS and they also tend to achieve a higher level of mutual trust (ibid.).

The specific rules that the farmers use in governing their systems on a day-to-day basis vary substantially from one system to another. The 'official' guard on many of these systems is one of the farmers themselves who 'rotates' into this position on a regular basis. The rules specifying allocation rules, responsibilities for monitoring, and punishment, however, are not consistent from one system to the next. Thus, the monitoring of water allocation and contributions to maintenance is largely performed by farmers who have participated in the crafting of the specific rules of their own system and have a strong interest in seeing their system perform well and ensure that others on the system are not free-riding or taking more water than their official share. These findings raise policy-relevant questions about the value of centralized and capital-intensive strategies for providing irrigation. They also confirm the importance of two design principles discussed below originally identified by Ostrom (1990): proportionality in benefits and costs, and collective-choice arrangements that involve individuals affected by the resource system.

Thus, farmers with long-term property rights, who can communicate, develop their own agreements, establish the positions of monitors, and sanction those who do not conform to their own rules, are likely to grow more rice, distribute water more equitably, and keep their systems in better repair than is the case in government systems. Since many of the government systems rely on high-tech engineering, the capability of farmers to increase agricultural production on their 'primitive systems' while they also provide the labor to maintain and operate the system, is particularly noteworthy.

In a recent paper, Lam and Ostrom (2010) examine the process and impact of an innovative irrigation assistance project that was undertaken in Sindhu Palchok in the mid-1980s under the imaginative leadership of Prachanda Pradhan and Robert Yoder. Using Qualitative Comparative Analysis (QCA), they found that the initial and later investments in system infrastructure are but one factor that may lead to longer-term success—but not simply that investment in infrastructure by itself, as has been so often recommended in the development literature. They found that unless the farmers organize themselves and create their own rules, and augment their rules through collective action or by imposing fines on those who violate rules, infrastructure investment alone is not sufficient for achieving sustainable higher performance.

The study of irrigation systems in Nepal is only one of the empirical studies we have undertaken over the past quarter of a century focusing on institutional arrangements and their impact on incentives, behavior, and outcomes. I will now provide a brief overview of our research related to forest resources and institutions.

Studying Forests around the World

A long-term collaborative research network—the International Forestry Resources and Institutions (IFRI) research program—was established in the early 1990s with centers now located in Bolivia, Colombia, Guatemala, India, Kenya, Mexico, Nepal, Tanzania, Thailand, Uganda, and the United States, with new centers being established in Ethiopia and China (see Gibson, McKean, and Ostrom 2000; Poteete and Ostrom 2004; Wollenberg et al. 2007; http://www.

sitemaker.umich.edu/ifri/home). IFRI is unique among efforts to study forests, as it is the only interdisciplinary long-term monitoring and research program studying forests owned by governments, by private organizations, and by communities in multiple countries.

A 'favorite' policy recommendation for protecting forests and biodiversity is government-owned protected areas (Terborgh 1999). In an effort to examine whether government ownership of protected areas is a necessary condition for improving forest density, Hayes (2006) used IFRI data to compare the rating of forest density (on a five-point scale) assigned to a forest by the forester or ecologist who had supervised the forest mensuration of trees, shrubs, and groundcover in a random sample of forest plots.[3] Of the 163 forests included in the analysis—76 were government-owned forests *legally designated* as *protected forests* and 87 were public, private, or communally owned forested lands used for a diversity of purposes. No statistical difference existed between the forest density in officially designated protected areas versus other forested areas. Our early studies focused on outcomes achieved by differently organized forests at one time period (see Agrawal 2001; Agrawal and Ostrom 2001; Regmi 2007).

We have now been able to return to some of our forest sites for a second or third visit (see Gautam, Shivakoti, and Webb 2004; Nagendra, Karmacharya, and Karna 2005; Nagendra 2007). Chhatre and Agrawal (2008) have now examined the changes in the condition of 152 forests under diverse governance arrangements as affected by the size of the forest, collective action around forests related to improvement activities, size of the user group, and the dependence of local users on a forest. They found that 'forests with a higher probability of regeneration are likely to be small to medium in size

3 Extensive forest mensuration is conducted at every IFRI site at the same time that information is obtained about forest users, their activities and organization, and about governance arrangements. Comparing forest measures across ecological zones is misleading since the average diameter at breast height in a forest is strongly affected by precipitation, soils, elevation, and other factors that vary dramatically across ecological zones. Thus, we ask the forester or ecologist who has just supervised the collection of forest data to rate the forest on a five-point scale from very sparse to very abundant.

with low levels of subsistence dependence, low commercial value, high levels of local enforcement, and strong collective action for improving the quality of the forest' (ibid.: 1327). In a second major analysis, Chhatre and Agrawal (2009) focus on factors that affect tradeoffs and synergies between the level of carbon storage in forests and their contributions to livelihoods. They find that larger forests are more effective in enhancing carbon and livelihoods outcomes, particularly when local communities also have high levels of rule-making autonomy. Recent studies by Coleman (2009) and Coleman and Steed (2009) also find that a major variable affecting forest conditions is the investment by local users in monitoring. Further, when local users are given harvesting rights, they are more likely to monitor illegal uses themselves. Many other focused studies also stress the relationship between local monitoring and better forest conditions (Ghate and Nagendra 2005; Nagendra 2007, 2008).

The legal designation of a forest as a protected area is *not* by itself related to forest density. But detailed field studies of monitoring and enforcement as they are conducted on the ground, illustrate the challenge of achieving high levels of forest regrowth without active involvement of local users (see Batistella et al. 2003; Agrawal 2005; Andersson, Gibson, and Lehoucq 2006; Tucker 2008). Our research shows that forests under different property regimes—government, private, communal—sometimes meet enhanced social goals such as biodiversity protection, carbon storage, or improved livelihoods. But at other times, these property regimes fail to provide such goals (Dietz, Ostrom, and Stern 2003). Indeed, when governments adopt top-down decentralization policies that leave local officials and users in the dark, stable forests may become subject to deforestation (Banana and Gombya-Ssembajjwe 2000; Banana et al. 2007). Thus, it is not the general type of forest governance that is crucial in explaining forest conditions; rather, it is how a particular governance arrangement fits the local ecology, how specific rules are developed and adapted over time, and whether users consider the system to be legitimate and equitable (for a more detailed overview of the IFRI research program, see chapter 5 in Poteete, Ostrom, and Janssen 2010).

Self-Organized Forests in Nepal

To focus in on one type of forest governance in a diversity of communities, let us briefly review a study conducted of eighteen self-managed forests in the Middle Hills of Nepal by George Varughese (1999). In this region, subsistence agriculture is the main occupation, although villagers do supplement their livelihoods by entering the market economy whenever opportunities arise. The rural population in the Middle Hills is mostly distributed in small villages or hamlets that are sometimes parts of larger, dispersed settlements. Forests are rarely located immediately adjacent to any one family. These forests are vital sources of fuelwood, fodder, and leaf litter for animal bedding and composting, especially in the winter months when agricultural residues are exhausted.

The indicators of forest conditions that Varughese used for comparison across the eighteen cases are of two kinds: forest stock and trend in forest condition. The indicator forest stock provides an assessment of forest condition at the time of the study by the forest specialists on the research team with respect to speciation and abundance of vegetation. The trend in forest condition is an assessment of forest condition derived from the historical perceptions of diverse local forest users, and, in many instances, of local government forest officials, about the relative abundance of produce, disappearance of valuable species, and change in forest area. 'Worsening' indicates their assessment of a clear depletion of species and reduction in forest area and 'improving' indicates their perception of an increase in abundance of tree species and shrubs and a general picture of resource use patterns and management.

The level of collective activity is strongly associated with forest condition, as shown in Table 3 (*tau* = 0.80). A high level of collective activity related to forest management is seen in five out of six forests (83 percent) of all forests that are improving in condition. In six out of seven forests (86 percent) where forests were found to be deteriorating, the local community was undertaking little or no collective activity. In the majority of locations where the forest resource was seen to be neither deteriorating nor improving, i.e., stable, the users were engaged in at least moderate collective action.[4]

Table 3. **Association of level of collective activity with forest condition**

Forest condition	Collective activity			Total
	High	Moderate	Low or None	
Improving	5(100%)	1(20%)	0	6
Stable	0	3(60%)	2(25%)	5
Worsening	0	1(20%)	6(75%)	7
Total	5(100%)	5(100%)	8(100%)	18

tau (ô) = 0.80

Source: Varughese (2000: 209).

In the rural areas of the Middle Hills of Nepal, differences in wealth (or economic endowments) relate directly to the extent of economic stratification within a forest association (or relative economic well-being) that, in turn, partially depends upon the occupation or livelihood strategy of each household (Gautam 2007). People's interest in forest resources differs based on whether or not they raise cattle for milk or goats for meat; run a tea shop or restaurant; weave baskets and mats; make charcoal or furniture; prepare medicine from forest products; use oxen for draught; or just cook food for the family. Most households need the forest for almost all of the above reasons. Given the general poverty of the Middle Hills, most user groups depend upon forests as an integral part of their daily subsistence, and few within any group have commercial interests in communal forests. The village blacksmith and the local tea-shop owner are two important exceptions.

In Nepal, villagers of different ethnicity or caste frequently reside in physically separate clusters (hamlets or *toles*) in a given settlement. How this affects their ability to cooperate is neither well-

4 See Varughese (1999) for an examination of the mechanisms that lie behind these positive associations.

understood nor studied in depth.[5] It is not uncommon to find that user groups have one or two castes that outnumber the rest. This may not translate directly into dominance, however, since lower castes can frequently be found in greater numbers than higher castes. Sociocultural composition has been observed to influence educational, economic, and political opportunities in Nepal. The skills that one group brings may complement those of other groups and, in some cases, be indispensable. In forest user groups, the more educated are sometimes from the higher castes. These individuals bring writing and bookkeeping skills that are essential to organization. Lower-caste individuals, who use forests for more specialized products than others, such as the artisans who work with charcoal and iron, bring their knowledge of flora and fauna to the group. For marking boundaries or trees, it frequently happens that some of the lower castes do most of that work.

Sociocultural differences in a group were determined by Varughese from information obtained on a minimum of three (if present, with no maximum) caste and ethnic types for each of the eighteen groups. Across the eighteen locations included in Varughese's study, he observed thirteen to be more heterogeneous in sociocultural composition, varying from moderate to high levels of heterogeneity. The proportion of cases where sociocultural heterogeneity was greater (over 60 percent) was also where collective action was seen to be high (eight of thirteen cases). In the cases where heterogeneity was lower (five of eighteen cases), there was almost no difference in the level of collective action (*tau* = 0.20).

Some of the groups who engaged in high levels of collective action also faced substantial heterogeneity. Varughese (2000) found that forest users had designed some ingenious rules to specifically take into account the heterogeneity they faced. This is particularly the case when users face locational differences.

5 Locational differences may operate quite independently of sociocultural differences, although these may be correlated in the Middle Hills since different ethnic/caste groups tend to live in their own hamlets, which may be at different distances from forested areas.

Two of the sites present particularly interesting cases. Both sites have highly organized user groups or associations with written rules and regulations governing user behavior with regard to the forest. In fact, both associations have overtly recognized that their membership is scattered and that the access to forested areas varies by settlement. In both cases, including settlements that are farther away generates substantial advantages to the group, and the rules of the group have been crafted accordingly. Both have a two-tier system of user membership. Those who live farther away can pay an extra fee in exchange for reduced monitoring duties. In addition, those who cannot participate in joint maintenance, harvesting, or monitoring activities can pay special membership fees so as to avail themselves of forest products at special, below-market rates. In one group, special membership is noted after payment of a fee; written requests for forest produce have to be processed by the Harvest Subcommittee; and the committee provides products to the member at a special rate.

To conclude our brief overview of research related to community management (including direct community ownership, government concessions, or other long-term comanagement arrangements), we have shown communities to be as effective or, under certain conditions, more effective than government ownership (Bray, Merino-Pérez, and Barry 2005). The debate over the effectiveness of institutions needs to be extended to a larger landscape of tenure regimes than just community ownership. Various forms of comanagement do assign substantial management responsibilities and access to resources in and around a resource, and a wide variety of community management types, from full ownership to community-rights concessions on public lands to private management, can be effective if they are well tailored to the particular attributes of a resource and the larger and smaller resources to which it is linked.

Some public policies have misunderstood the difference between self-organized systems and centralized government policies to 'decentralize' the governance of a resource. We find a variety of outcomes when forest resources have been 'decentralized' in a centralized manner (Agrawal and Gupta 2005; Agrawal and Ostrom 2008; Webb and Shivakoti 2008). When the forest users do have a voice in the design of the rules they will be using related to forest and other resources, they can frequently devise rules well matched to the complexity of the ecological system involved (Gautam 2007). Simple solutions do not exist, however, for managing complex ecologies (Campbell et al. 2006; McPeak, Lee, and Barrett 2006). Thus, our research illustrates that enabling resource users to have a significant voice in the governance of natural resources can lead to sustainable outcomes, but we must be careful not to presume that there is a simple way to 'decentralize' the governance of resources using a single formula for an entire region or nation.

From Optimal Solutions to Adaptive Multilevel Governance

A key finding from decades of in-depth studies of institutions and the environment is that the same rules that work well in one setting are part of failed systems elsewhere! There are no 'optimal' rules that can be applied to all fisheries, all forests, or all water systems (Grafton 2000; Ostrom 2007). We simply must stop relying on stick-figure models alone and proposing 'one-size-fits-all' solutions, given that these solutions have themselves generated tragedies when widely applied rather than solved them.

Institutional theorists need to recognize what ecologists recognized long ago: the complexity of what we study and the necessity of recognizing the nonlinear, self-organizing, and dynamic aspects as well as the multiple objectives and the spatial and temporal scales involved. As the distinguished ecologist Simon Levin (1999: 2) has summarized:

That is, ecosystems are complex, adaptive systems and hence, are characterized by historical dependency, complex dynamics, and multiple basins of attraction. The management of such systems presents fundamental challenges, made especially difficult by the fact that the putative controllers (humans) are essential parts of the system and, hence, essential parts of the problem . . .

There are a number of lessons that emerge from this study and guide it. Most important is the importance of experimentation, learning and adaptation.

Institutional economists need to recognize that deriving a simply beautiful mathematical model is not the only goal of our analysis. Adopting more complex approaches—including flow charts, simulations, dynamic systems analysis, and the specification of multiple factors—is not a sign of failure when the systems being analyzed are fundamentally complex and multilevel (Wilson 2006; Wilson, Yan, and Wilson 2007). We also need to draw on research using multiple overharvesting.

Thinking about Policy Recommendations

In earlier efforts to analyze which rules worked best related to fisheries, irrigation systems, and forests, we found a simply gigantic number of individual rules that were used in the field (Tang 1994; Schlager 1994; Ostrom 2005). It is important to note that repeated studies have not yet found *specific* rules that have a statistically positive relationship to performance in a large number of common-pool resources (Gibson, McKean, and Ostrom 2000; NRC 2002; Dietz, Ostrom, and Stern 2003). On the other hand, the absence of *any* boundary rule or *any* monitoring effort to ensure that a well-defined set of authorized users are following the rules related to timing, technology, and quantity of harvesting *is* consistently associated with poor performance (Ostrom and Nagendra 2006; Ostrom, Gardner, and Walker 1994).

After reading and coding hundreds of cases that described both successful and unsuccessful private, government, and community property arrangements, without finding a clear set of *specific* rules associated with long-term sustainability, I derived a set of design principles to characterize those cases of local, common-pool resources that had survived long periods of time (Ostrom 1990). The predictive power of these design principles in helping to distinguish successful from unsuccessful cases has now been supported by multiple studies (Weinstein 2000; Trawick 2001;

Marshall 2005; Dayton-Johnson 2000; Sarker and Itoh 2001; Cox et al., in press).

To apply what we have learned to policy, we can translate the design principles into a set of questions that those involved in designing and adapting institutional arrangements for a particular resource system should be encouraged to address. Basically, any institutional arrangement for regulating a common-pool resource to achieve multiple objectives needs to help harvesters and officials address the following questions in a way that is understood by those involved and considered legitimate given the characteristics of the resource, the community involved, and the larger economic and political domains:

- How are we going to define the boundaries of this resource over time?
- Who is allowed to harvest which kinds of resource units?
- What will be the timing, quantity, location, and technology used for harvesting?
- Who is obligated to contribute resources to maintain the resource system itself?
- How are harvesting and maintenance activities to be monitored and enforced?
- How are conflicts over harvesting and maintenance to be resolved?
- How will cross-scale linkages be dealt with on a regular basis?
- How will the rules affecting the above be changed over time with changes in the performance of the resource system, the strategies of participants, and external opportunities and constraints?

Instead of presuming that one can design an optimal system in advance and then make it work, we must think about ways to analyze the structure of common-pool resources, how these change over time, and adopt a multilevel, experimental approach rather than a top-down approach to the design of effective institutions.

Experimenting with Rule Changes

We need to understand the institutional design processes involving an effort to tinker with a large number of component parts (see Jacob 1977). Those who tinker with any tools—including rules—are trying to find combinations that work together more effectively than other combinations in a particular setting. Policy changes are experiments based on more or less informed expectations about potential outcomes and the distribution of these outcomes for participants across time and space (Campbell 1969, 1975). Whenever individuals agree to add a rule, change a rule, or adopt someone else's proposed rule set, they are conducting a policy experiment. Further, the complexity of the ever-changing biophysical world combined with the complexity of rule systems means that any proposed rule change faces a nontrivial probability of error.

When rules related to common-pool resources are made by a single governing authority for an entire nation, policymakers have to experiment simultaneously with *all* of the common-pool resources within their jurisdiction with each policy change. For very small countries with similar ecosystems, this may not be a problem. For countries with diverse ecologies, however, rules that are appropriate in one region are rarely effective in another. And, once a change has been made and implemented, further changes will not be made rapidly. The process of experimentation will usually be slow, and information about results may be contradictory and difficult to interpret. A policy change that is based on erroneous data about one key structural variable or a false assumption about how actors will react, can lead to a major disaster (see Brock and Carpenter 2007; Berkes 2007). Further, as Dixit (2004) has shown, arbitrary policy changes and tax laws made by a highly centralized governance regime may result in substantial rent seeking and graft.

In any design process where there is a substantial probability of error, having redundant teams of designers has repeatedly been shown to have considerable advantage (see Landau 1969, 1973; Bendor 1985; Page 2007). Given the logic of combinatorics, it is impossible to conduct a *complete* analysis of the expected performance of all of the potential rule changes that could be made to change the incentives of resource users. Instead of developing models that generate optimal outcomes, we need to understand what level of redundancy, overlap, and autonomy help to adapt rules that work for particular resources under specific social-economic conditions. And, then, we need to focus on how to enhance the robustness of these institutions to diverse disturbances that will 'hit' them over time (Anderies et al. 2007; Janssen, Anderies, and Ostrom 2007).

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2004: Kumar Pradhan—**दार्जीलिङमा नेपाली जाति र जनजातीय चिनारीका नयाँ अडानहरू**

2003: Harka Gurung—**Trident and Thunderbolt: Cultural Dynamics in Nepalese Politics**

Mahesh Chandra Regmi
(1929-2003)

The Mahesh Chandra Regmi Lecture was instituted by the Social Science Baha in 2003 to acknowledge and honour historian Mahesh Chandra Regmi's contribution to the social sciences in Nepal.

Elinor Ostrom delivered the Mahesh Chandra Regmi Lecture 2010 on the 7th of December. Nobel laureate Ostrom is Distinguished Professor, Arthur F. Bentley Professor of Political Science, and Senior Research Director of the Workshop in Political Theory and Policy Analysis, Indiana University, Bloomington; and Founding Director, Center for the Study of Institutional Diversity, Arizona State University. Her books include *Governing the Commons* (1990); *Rules, Games, and Common-Pool Resources* (1994, with Roy Gardner and James Walker); *Local Commons and Global Interdependence: Heterogeneity and Cooperation in Two Domains* (1995, with Robert Keohane); *The Commons in the New Millennium: Challenges and Adaptations* (2003, with Nives Dolšak); *Understanding Institutional Diversity* (2005); *Understanding Knowledge as a Commons: From Theory to Practice* (2007, with Charlotte Hess); and *Working Together: Collective Action, the Commons, and Multiple Methods in Practice* (2010, with Amy Poteete and Marco Janssen).

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