

What Makes Joint Forest Management Successful? Science-Based Policy Lessons on Sustainable Governance of Forests in India

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of Forests in India**

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The Rajasthan State Pollution Control Board is a body corporate constituted under section 4 of the Water (Prevention and Control of Pollution) Act, 1974. It was first constituted on February 7, 1975, with the objectives of prevention, and control of water pollution and maintaining or restoring of wholesomeness of water. Later, it was also entrusted with the responsibilities of prevention, control and abatement of air pollution under the provisions of Air (Prevention and Control of Pollution) Act, 1981. Water (Prevention and Control of Pollution) Cess Act, 1977 has been enacted to make the State Board financially independent. Under this act the State Board has been given powers to collect cess on the basis of water consumed by the industries and others. Besides, the State Board is also implementing the provisions of the Public (Liability) Insurance Act, 1991. Enactment of the Environment (Protection) Act, 1986 has further widened the scope of the activities of the Board. This act being umbrella legislation, different rules for addressing the problems of various sectors have been enacted under this act. Currently, the State Board is engaged in implementation of the following rules under EPA, 1986:

- Hazardous Waste (Management, Handling and Transboundary Movement) Rules, 2008.
- Manufacture, Storage & Import of Hazardous Chemical Rules, 1989.
- Public (Liability) Insurance Act, 1991.
- Environmental Impact Assessment (Aravali) Notification Dated 7.5.1992.
- Environmental Impact Assessment Notification dated 14.09.06.
- Bio Medical Waste (Management & Handling) Rules, 1998.
- Plastic Manufacture & Usage Rules, 1999.
- Noise (Pollution Control & Regulation) Rules, 2000.
- Municipal Solid Waste (Management & Handling) Rules, 2000.
- Batteries (Management & Handling) Rules, 2001.

Recently, **Climate Change and CDM Cell** has been established at RSPCB to facilitate the dissemination of knowledge relevant to climate change adaptation and mitigation in Rajasthan.

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SUMMARY

Forests are vital for social, economic, ecological and environmental reasons. They play an important role in ecosystem processes (such as the biogeochemical and hydrological cycles), they provide habitat for wildlife and serve as sources of biodiversity, and they offer protection against soil erosion. Forests are also among the most effective systems for air pollution abatement and ground water recharge. In this era of global warming, forests help mitigate the effects of climate change, and maintain biodiversity and ecosystem functioning. However, in spite of their obvious value, human activity is causing unprecedented threats to forest ecosystems. Therefore, a serious attention to the factors that lead to effective forest governance is essential to address forest restoration and management challenges in India. A large number of variables are suggested in literature that may potentially determine success or failure of sustainable governance of forests, yet the success in finding the most essential factor for sustainability has remained elusive. This paper reviews recent research and demonstrates that even when a number of other factors are taken into account, higher levels of local monitoring and enforcement of locally-made rules can result in improved forest restoration and lower the possibility of forest degradation across a variety of ecological, economic and social contexts. It is essential to emphasize here that strong autonomy of rule-making at the local level (and not the government-imposed rules) is a key predictor of both better forests as well as better availability of goods and services to support livelihoods of local people. These science-based policy lessons have immediate practical utility for evidence-based forest management and restoration in India. There is an urgent need for the establishment of credible local monitoring, local rule-making and local enforcement systems in every village-level organization to facilitate local learning and adaptation. In the context of joint forest management, it is expected that village forest management and protection committees that have local rule-making, local monitoring and local enforcement are more likely to succeed in their efforts directed towards better forests and improved livelihoods. We must strive to enhance the quality of governance because such efforts result in decrease in deforestation and long-term carbon storage in forests globally. Effective local institutional arrangements to govern forests substantially influence carbon storage and livelihood contributions.

1. Introduction

There have been numerous attempts by researchers and practitioners to identify factors that determine the sustainability of forests in general and community-based approaches in particular. Indeed, a large number of variables are suggested in literature that may potentially determine the success or failure of forest governance. For instance, a review of large body of earlier research identified 33 critical enabling factors for sustainability of the commons resources (Agrawal, 2001). Another meta-analysis of 31 articles on community forestry, encompassing 69 case studies worldwide identified 43 independent variables that influence the success or failure of community forestry (Pagdee *et al.*, 2006). Indeed, there are many other context-specific studies that identify factors responsible for successful resource management outcomes (Wade, 1988; Ostrom, 1990; Baland and Platteau, 1996; Dietz, *et al.* 2003; Agrawal and Chhatre, 2006; Nagendra, 2007; Pandey, 2007 & 2010; Ostrom, 2007, Pandey, Tucker, 2010; see, annex. 1). Notwithstanding these efforts, success in finding critical drivers has remained elusive. There is now a great urgency to identify institutional mechanisms that are most likely to succeed in management of multifunctional forests in an era of growing anthropogenic stresses and climate change (Pandey, 2002). Increasing the quality of governance is necessary because such efforts tend to be associated with a decrease in deforestation rates and long-term carbon storage globally (Umehiya *et al.*, 2010).

The search for leading success factors is often hampered, because field-based data collection, using uniform methods across continents and countries (i.e. large-N studies based on a large number of sample sites) have been difficult to design and implement. While good science on its own is no guarantee for better implementation, production of knowledge from large-N studies is necessary to improve policy and practice in field. A research network called International Forestry Resources and Institutions (IFRI) is attempting to precisely resolve this issue. IFRI is a unique field-

based research network that has accumulated sufficiently comparable data to support large-N analyses related to collective action in natural resource management (Poteete and Ostrom, 2008). The Nobel Prize for 2009 in Economic Sciences has been awarded to Elinor Ostrom who made major contributions to our understanding of the governance of forests and common pool resources. Ostrom has spent considerable amount of time and efforts with IFRI programme that produced some of the most useful research relevant to practitioners of natural resource management.

This review presents fresh interpretation of available research and provides justification for instituting local monitoring and enforcement systems in the field for sustainable governance of India's forests. The review also aims to identify lessons for consolidation of joint forest management as a tool for sustaining the forests and improving livelihoods of people. A word of clarification shall be in order here. This paper is not a review of JFM in India. As mentioned above, our purpose here is to draw on cutting-edge multidisciplinary research to suggest ways for improvement in JFM.

2. Reasons for focus on community-based management systems

There are three motivations for our focus on the community-based management systems. First, influenced by the seminal paper by Hardin (1968) titled as "The Tragedy of the Commons", accepted theory has assumed that forest users will never self-organize to maintain their resources and that the common property, such as forests, should either be privatized or governments must impose control. Elinor Ostrom (1990) challenged this conventional wisdom that common property governance necessarily implies a "tragedy". A third solution—rather than privatization or government control—she argued, is to facilitate the users create their own system of governance. Drawing on a large body of available evidence on the management of common pool resources, Ostrom (1990) found that local users themselves can indeed design rules and enforcement mechanisms

that enable them to sustain resources. Since then, experiential knowledge as well as research in multiple disciplines, have again and again confirmed that “the tragedy of the commons” is not inevitable (Ostrom, 1999a&b; Ostrom, *et al.* 1999; Ostrom, 2009). No single ownership— government, private, or community— uniformly succeeds or fails to prevent forest degradation. As shown for forests across several countries, some government policies accelerate resource destruction, whereas some resource users have invested their time and efforts to achieve sustainability (Dietz *et al.*, 2003).

Our second reason for concentrating on community-based approaches in this review is that while community-based management is only one of the approaches to forest governance (Dietz *et al.*, 2003; Agrawal *et al.*, 2008), evidence is now mounting that monitoring and enforcement by community-based institutions can potentially halt deforestation and bring forest transition (Nagendra and Gokhale, 2008). When management is initiated and owned locally, communities have demonstrated their capacity for putting effective and adaptive forest management practices in place to address future forest governance (Ostrom and Nagendra, 2006; Pandey, 1993 & 2003). Effective implementation of community-based forest management also offers potentially significant livelihoods outcomes. Indeed, institutional arrangements to govern forests that incorporate local knowledge and decentralized decision making substantially influence carbon storage and livelihood contributions (Chhatre and Agrawal, 2009). A recent study (Milne *et al.*, 2006) estimated that for the area presently under JFM alone in India, total forest income from commercial timber, bamboo and non-timber products on improved forests could rise from an estimated US\$222 million in 2004 to approximately US\$2 billion per annum in 2020. These potentials could only be realized if effective systems of forest governance in India are implemented.

Our third motivation for focusing on the community-based management systems

is the factors such as efficiency and cost-effectiveness. For instance, state forests in Central Himalaya cost at least 7 times as much per hectare to administer as do village council-managed forests with similar outcomes (Somanathan *et al.*, 2009). While, this particular conclusion for Himalaya has been questioned by the forest managers, the practitioners in general acknowledge that community-management systems including JFM and van panchayat forests are indeed more cost-effective than government-managed systems. In terms of degradation, forests managed by local communities (Van Panchayats), relative to state protected and open access forests in the Uttarakhand suggests that Van Panchayat forests are 20-30% less lopped. Further, longer the forest has been under a Van Panchayat lesser is the lopping (Baland et al. 2010). Thus, local management is likely to be more cost-effective than state management, and therefore worth promoting.

3. Technical interventions to generate multiple benefits from JFM areas

There have been numerous advances on technical interventions in forestry, particularly from the perspectives of livelihoods as well as climate change mitigation and adaptation, suggesting that forests are required to play multifunctional role. These include, but are not limited to, biodiversity conservation and maintenance of ecosystem functions; yield of goods and services to the society; enhancing the carbon storage in trees, woody vegetation and soils; and providing social and economic well-being of people. Before we move on to governance, it is worthwhile to keep in mind the interventions that would be useful in fulfilling the economic, ecological and societal objectives. The interventions helpful in realizing the full potential of joint forest management need to be routinely integrated into effective local governance systems. These may include:

- Representation of all forest types in protected areas, both formal and indigenous regimes.
- Protection of natural forests against

- wild-fires, grazing, and unmanaged removals.
- Priority protection to threatened ecosystems such as tropical dry forests of Rajasthan.
 - Preventing fragmentation and providing connectivity to conserve biodiversity in landscape continuum. Fragmentation of natural forests has a sequential path that starts with killing of big trees followed by degeneration of habitat specialists, paucity of regeneration due to impoverished seed germination in fragments, and ends in denuded areas.
 - Maintenance of gene pool diversity in natural and cultural landscapes
 - Restoration of degraded forests with multiple use trees, shrubs and herbs along with regeneration regimes that necessarily combine rainwater harvesting, direct seeding, resprouting, stake-planting, and plantations.
 - Protection and management of natural regrowth that may be able to supply a variety of goods and services depending on the age and condition of the forest.
 - Restoration plantings using small number of short-lived nurse trees and shrubs capable of enhancing diversity depending on the colonization from nearby forest remnants. Primary benefit is likely to be supply of ecological services although it can also supply some goods depending on species.
 - Protection and management of natural regrowth plus enrichment with key species that are commercially, socially, or ecologically useful, and can improve the value of forests to local communities.
 - Restoration plantings using large number of species from later successional stages, resulting into higher initial diversity that will also be supplemented by colonization from nearby forest remnants. Primary benefit is ecological services, although can supply some goods depending on species used.
 - Direct seeding of a combination of both leguminous and non-leguminous species can be used to initiate reforestation in barren areas. It can also be very useful to enhance diversity and productivity in depleted forests.
 - Maintenance of woody vegetation in ethnoforestry regimes in landscape continuum (households, cultural landscapes, agroecosystems, and wilderness). Protection to a variety of woody vegetation management regimes in agroecosystems to maximize social and economic benefits to the people as well maintenance of ecosystems functions such as natural pest control, pollination, carbon storage, regulation of hydrological cycle etc.
 - Mixed species tree plantation used as a nurse crop with underplantings of native species not otherwise able to establish at the site. Fast-growing nurse crop supplying commercially useful timbers or other goods can facilitate (e.g., via nitrogen fixation and microclimate alterations) the subsequent establishment of more species-rich forests that supply a wider range of goods and services. Leguminous species can enhance soil microbial biomass and N mineralization and promote growth of other saplings growing in their vicinity.
 - Only low intensity logging followed by matching regeneration in secondary forests and ethnoforestry regimes.
 - Protection of the functional groups of biodiversity. As several keystone species are also socio-culturally valued, their inclusion in ecological restoration programme is helpful.

Examples of such species are *Ficus religiosa* and *Ficus bengalensis*, *Bombax malabaricum*, *Prosopis cineraria*, and *Acacia* species. Fruit-eating animals and birds prefer to eat figs even when other food is abundant, because high calcium levels contribute to the desirability of figs as food for many animal species.

- Protection to large trees in natural, cultural and human modified landscapes as they act as seed source, conserve carbon pool, and act as habitat for seed-dispersing birds, small mammals, and other faunal species.
- Soil conservation and enhancement of soil fertility through conservation/restoration of woody leguminous species across landscape continuum.

4. Core Variables that characterize sustainable governance of forests

In this section we discuss key factors which scientists and practitioners both suggest to be important for sustainable governance of forests. Two sets of factors, one proposed by leading research (given in section 4.1) and another by field practitioners (given in section 4.2) would be useful for drawing lessons to strengthen JFM.

As suggested earlier, we wish to draw on core underlying lessons derived from science and experience that characterize the long sustained governance regimes as contrasted to the cases of failure. Thus, it would be useful for the practitioners of JFM to ensure that their governance systems have all the elements of success factors in place, with appropriate context-specific adaptations, to ensure the sustainable governance of forests. While concluding this paper, we shall draw on both set of factors to suggest ways for improving JFM practice.

4.1. The institutional design principles for sustainable governance

The design principles, first proposed by

Ostrom (1990 & 2005), appear to synthesize core factors that affect the probability of long-term survival of an institution developed by the users of a resource. Recently, Cox et al. (2009) analyzed over 100 studies by scholars who assessed the relevance of the principles as an explanation of the success or failure of diverse common-pool resources. Two-thirds of these studies confirm that robust resource systems are characterized by most of the design principles and that failures are not. A brief updated list as developed by Cox et al. (2009) and cited by Elinor Ostrom in her Nobel Lecture, December 8, 2009 is as follow:

1A. User Boundaries: Clear and locally understood boundaries between legitimate users and nonusers are present.

1B. Resource Boundaries: Clear boundaries that separate a specific common-pool resource from a larger social-ecological system are present.

2A. Congruence with Local Conditions: Appropriation and provision rules are congruent with local social and environmental conditions.

2B. Appropriation and Provision: Appropriation rules are congruent with provision rules; the distribution of costs is proportional to the distribution of benefits.

3. Collective-Choice Arrangements: Most individuals affected by a resource regime are authorized to participate in making and modifying its rules.

4A. Monitoring Users: Individuals who are accountable to or are the users monitor the appropriation and provision levels of the users.

4B. Monitoring the Resource: Individuals who are accountable to or are the users monitor the condition of the resource.

5. Graduated Sanctions: Sanctions for rule violations start very low but

become stronger if a user repeatedly violates a rule.

6. Conflict-Resolution Mechanisms: Rapid, low-cost, local arenas exist for resolving conflicts among users or with officials.

7. Minimal Recognition of Rights: The rights of local users to make and enforce their own rules are recognized by the government.

8. Nested Enterprises: When a common-pool resource is closely connected to a larger social-ecological system, governance activities are organized in multiple nested layers.

4.2. Experiential knowledge on success factors

The core enabling factors for sustainability based on experiential understanding of more than 500 practitioners in the field that determine the success of joint forest management in India (Pandey, 2010) are as follows:

1. Institutions: Locally evolved institutional arrangements (i.e., norms, rules and regulations which are locally made and enforced) are major factors that contribute to functioning of JFM. Good leadership and layered institutions are helpful in local rule making, local monitoring and local enforcement.

2. Interaction: Effective governance of forests is easier to achieve when stakeholders maintain frequent face-to-face communication. This increases trust, allows people to express and see reactions to conflicts and distrust, learn from each other, and lower the cost of inducing rule compliance. These interactions also contribute to social capital, social networks, and peer-to-peer learning. The crucial issue to watch here is how the decision taken in these interactions are followed (for example, ways in which promises are kept or broken, or conflicts are resolved).

3. Monitoring and adaptations: Local monitoring is a powerful tool for management of ignorance among stakeholders and managers. Participatory monitoring helps generate locally-relevant data, information and knowledge, and induces adaptive actions by stakeholders for using knowledge for solid actions on the ground.

4. Local rule making and local enforcement: As opposed to external rule making and enforcement by Government, local rule making and local enforcement is the key driver for success. Key indicators of existence of local enforcement are continuous learning about the social—ecological systems, rule compliance, patrolling, guarding against unauthorized use, fines and sanctions in dealing with offenders.

5. Livelihoods improvement: Livelihoods improvement through JFM is expected to be realized through four ways—employment, village development, sharing of goods, and sharing of service payments. Payments for environmental services (ecotourism, watershed protection, carbon sequestration, biodiversity conservation) provide new avenue for livelihoods improvement.

6. Generating and linking knowledge to action: Linking knowledge to action (i.e., adaptive actions, enforcement) is necessary so that the creative ideas result in solid innovations. Additional components include availability of resources to link knowledge to action, seamless access to knowledge, a habit of evidence-based decision making, co-production and co-synthesis of problem-based knowledge, and integration of knowledge systems.

5. Critical importance of local monitoring and enforcement

Science has developed a more focused understanding, beyond what we discussed in section 4 above, about the critical factors. In this section, therefore, we now turn to recent advances to identify factors that may be critically important for the success of joint forest management. As discussed earlier, while a large number of different causal factors may potentially influence the management outcome in the field (see, annex. 1), local monitoring and enforcement of locally-made rules is now emerging as one of the most important determinants of sustainable governance of forests and protected areas (Gibson *et al.*, 2005; Hilborn *et al.*, 2006).

The pioneering study by researchers at IFRI (Gibson *et al.*, 2005) demonstrated that fundamental necessity of just one factor—enforcement—is so critical for the better outcome of natural resource management that other factors (such as high level of social capital, presence of formal organization, and peoples' degree of dependence on forest products) seem either less important, or these factors may simply influence the outcome via their positive effect on monitoring and consequent improvement of interventions on the ground. The study showed that it is highly unlikely for forest condition to be good if there is no monitoring and rule enforcement regardless of whether social capital of stakeholders is high or low. Likewise, better forest outcome is also associated with rule enforcement regardless of the degree of formal organization of the stakeholders. And finally, better monitoring and local rule enforcement is also significantly associated with better forest condition, regardless of whether or not a group's dependence on the forests is light or heavy.

Advancing the research on local enforcement, recent work (Chhatre and Agrawal, 2008) used a sample of 152 cases from 9 countries, including India, to study the relationship of enforcement with changes in the condition

of forests. The analysis examined local enforcement in conjunction with four other factors that are supposed to be central to the sustainable governance of forests: size of forests, collective action around forests, user group size, and dependence on forests. The analysis also explores how local enforcement moderates the impact of these four factors.

This new research shows that forests with a higher probability of regeneration are likely to be small to medium in size 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. Larger forests in the sample with high subsistence dependence, low enforcement, and high commercial value have a higher probability of having degraded. While the influence of individual factors—group size, patch size, collective action, subsistence dependence, and commercial value—is as predicted, Chhatre and Agrawal (2008) demonstrate the significant role played by the level of enforcement in moderating the influence of these factors on changes in the condition of forests.

In terms of local enforcement, collective action, and changes in forest condition, Chhatre and Agrawal (2008) find that probability of degradation of a forest declines with increases in the level of local enforcement, and, as expected, the probability of regeneration increases with levels of enforcement. Controlling for other factors, forests with high levels of enforcement are far more likely to have regenerated compared to those with no enforcement even for large sized forests. Forests where local communities have undertaken collective action related to improvement activities (planting of saplings and weeding and hoeing) are more likely to have regenerated. But more importantly, as the study shows, “such forests respond better to increasing levels of enforcement, so that a forest with improvement activities has a more than 50% probability of regeneration at a medium level of enforcement, compared to a 25% probability for regeneration for forests without any improvement activities

but the same level of enforcement” (Chhatre and Agrawal, 2008). Likewise, change in level of enforcement has a similar effect on the relationship between change in forest condition and improvement activities, i.e. higher the levels of enforcement more the probability of forest regeneration and lesser the probability of degradation.

In terms of local enforcement, forest use/dependence, and changes in forest condition, the study demonstrates that the number of people using a forest for subsistence has almost no relationship with the probability of degradation. Instead, they find that the probability of degradation increases—and probability of regeneration decreases—with increasing proportion of firewood needs supplied from a forest. But, this relationship changes when enforcement comes into picture: “Forests that supply higher levels of firewood and also have high levels of enforcement have a more than 60% probability of regeneration, compared to less than 20% for forests with similar firewood dependence but no local enforcement” (Chhatre and Agrawal, 2008).

In an era of global climate change forests are required to be managed in such a way that they play a multifunctional role such as contributions to mitigation of climate change through carbon storage and livelihoods improvement of forest-dependent people (Adams *et al.* 2004, Benayas *et al.* 2009, Canadell and Raupach 2008, Chazdon 2008, Lamb *et al.* 2005, Pandey, 2002). In this connection, data derived from 80 forests in 10 countries across Asia, Africa, and Latin America collected using IFRI methods demonstrate that that increasing forest size and greater local autonomy in making appropriate rules to match resource characteristics result in a win–win relationship with carbon storage and livelihood benefits from forest commons (Chhatre and Agrawal, 2009). In the absence of monitoring, the sanctioning and enforcement mechanisms become weak (Coleman, 2009). Thus, local monitoring and enforcement of rules are crucial, but it is essential to emphasize here that autonomy of rule-making at the local level (and not the government-imposed rules)

is a key predictor of both better forests as well as better availability of goods and services to support the livelihoods of local people.

The long-term sustainability of rules devised at local level depends on monitoring and enforcement as well their not being overruled by larger government policies. As the studies on forest commons reviewed here show, the long-term effectiveness of rules depends on willingness of resource users to monitor one another’s harvesting practices (Ostrom, 2009). These crucial investigations emanating from IFRI are of exceptional importance in the domain of sustainability science. These studies not only examine the importance of enforcement in combination with a large number of other causal factors, they also draw on field data on local forestry initiatives from multiple countries, including India. To our knowledge these are the most comprehensive and significant scientific works that provides insights on collective action with practical implications for sustainability of forests.

6. Motivations for designing rules that are well-enforced

As discussed here, the existence of monitoring of resource use and local enforcement of locally-made rules has a strong correlation with improved forest condition. But this also begs the question: why some forests have rules that are well enforced, and others do not? Three recent studies have attempted to break new grounds in this direction. One of the studies examined the role of informal and formal institutions in monitoring and sanctioning. Results of the study (Coleman and Steed, 2009) using data from 100 forests in 14 countries collected by IFRI show that when local user groups are given the right to harvest from the forest, they are more likely to engage in local monitoring and sanctioning. The other study, based on the IFRI data from 12 countries representing 173 distinct forests and 230 distinct user groups, suggests that user groups that are formally organized, that have users that are involved in making rules, and that engage in monitoring and sanctioning outside

of the forest are more likely to engage in rule-enforcement (Fleischman, 2009). Further, third study explains the reasons for variation in communities' ability to devise forms of good governance, for example, establishing a monitoring system. Being organized, having learned from other collective problem-solving experiences, having leaders, and having the autonomy to craft their own governance regime are amongst the variables that seem to contribute significantly to a group's ability to overcome collective action dilemmas related to initiating, adapting and sustaining an effective forest governance system. However, before village groups start thinking about organizing collective action, its members require the guarantee that other groups will not free ride on their group's collective effort (Van Laerhoven, 2010).

Recent studies on JFM demonstrate the beneficial impact of women's presence in village organization on conservation outcomes, mainly attributable to women's contributions in designing the stricter rules as well as improved rule compliance (Agarwal, 2009 & 2010).

As reviewed here, rule making autonomy by local forest users is important for forest conservation. However, local institutions also face governance challenges from external sources. Independent external organizations may usefully mediate these challenges. A recent synthesis suggests that successful sustained forest management depends on institutional arrangements that (1) establish local resident rulemaking autonomy, (2) facilitate the flow of external financial and institutional assistance for monitoring and enforcement of local rules, and (3) buffer residents and their respective local institutions from more powerful actors and agencies involved in forest exploitation. Thus, there is a role for external, independent non-governmental organization to help mediate demands on local forest governance systems in nested contexts (Hayes and Persha, 2010). For instance, JFM communities initiated by NGOs in Orissa have been found to be more likely to manage forests effectively than the

one initiated by the Forest Department alone (Behera 2009).

7. Classic example of local monitoring and enforcement of locally-made rules

In the indigenous systems of forests management and biodiversity conservation the leading cause for long-term sustainability is the presence of locally-designed systems for monitoring, rulemaking and enforcement (for a comprehensive analysis on this issue, see, Pandey, 2001, Berkes et al., 2000, Nagendra and Gokhale, 2008). Here we provide only a selection of examples.

Sacred groves and *Orans* protected by village communities are one of the finest instances of traditional conservation practices. *Deora* of southern Aravallis and *Orans* of Thar desert consist of a variety of trees. Sacred groves dedicated to village deities have higher density of trees compared to the surrounding landscape. Sacred groves have multifarious ecological and economic functions including habitat to biodiversity, watershed protection, sources of seeds for afforestation, nest site to birds and animals, and source of water for irrigation taken to long distances through traditional irrigation channels constructed along the contours. These areas have survived for a very long period of time because the communities—and not the Government—have designed their own rules for protection that are well-enforced through a variety of mechanisms (Pandey, 1993 & 1996).

Similar rules-in-use can be seen in a tradition called “keshar-chhanta” (sprinkling of saffron) that has helped protect several areas of forests. People collect saffron from nearby temple and sprinkle it collectively around natural forest patch; this puts voluntary restriction on green felling. Forests are thus treated as de facto sanctuaries being maintained and protected by people living in and around the forest. Kesar Chhanta not only protects the forest against the green felling, it also allows birds and wild animals to roam freely in the area. Management practices in Kesar Chhanta forest

include protection, patrolling by community appointed watchman, restriction to green felling, equitable gathering of dead and fallen wood, harvest of non timber forest produce and grasses. These areas represent the ultimate example of local enforcement of locally-made rules where community monitors its own behaviour and punishes its own members for any act not permitted by Kesar Chhanta tradition. Kesar Chhanta forests also protect water sources, life history stages, medicinal herbs and fruit bearing species (Pandey, 1993 & 1996).

8. Lessons for improvement of the JFM on the ground

Joint Forest Management in India, as the largest community forestry initiative globally, embraces the philosophy of sustaining the forests and improving the livelihoods. Accordingly, Forest Department makes strong claims about the contribution of JFM to both improvement of forests as well as livelihoods of people. These claims and the stated objectives of JFM notwithstanding, evidence in favour of the impact of JFM on livelihoods improvement and betterment of forests remains contested, and the outcome remains mixed. Indeed, there has been a sharp criticism of the programme. It is claimed that the very basis of JFM was for people's involvement in the development and protection of forests, yet it has failed in its attempt to utilise forest wealth to improve local livelihoods (Sarker 2009). The criticism is not limited to its failure to improve livelihoods, many operational challenges also remain (see, Kashwan 2006). In recent times, JFM has also failed to sustain the growth in afforestation achieved during the 1990s (Chakrabarti and Datta, 2009). These are reasons for concern to practitioners.

Connecting science to decision making is fundamental to sustainability of forests, and livelihoods of people dependent on these ecosystems. There is, thus, an urgent need for the establishment of credible *local monitoring*, *local rule-making* and *local enforcement* systems in every village-level

JFM organization to facilitate local learning and adaptation. Further, local enforcement is often most effective in the case where forest management is initiated by the community, with better regeneration, and negligible evidence of grazing and fire. Inefficient monitoring is often apparent in the state-initiated JFM village, with uncontrolled grazing and fire, leading to heavy damage to the forest (Ghate and Nagendra 2005). Unfortunately, even the recent JFM literature claiming to provide the “retrospective evaluation to take stock of its actual achievements, its status and ways forward” as well as “critical design factors” does not yet seem to recognize these critical necessities of local forest governance (see, Bhattacharya *et al.* 2010).

We are now at a juncture when enough scientific evidence is available to persuade practitioners to craft robust systems of monitoring and enforcement in community-based forest management systems. Practitioners themselves have argued earlier that given the stakes and complexity involved, the crux of the sustainability of JFM is the proper monitoring and adaptation (Ghose, 1996; Pandey, 1996). As demonstrated here, these sentiments have been reinforced through new and accumulating empirical evidence for giving the desired thrust for local monitoring to generate context-specific knowledge, and local enforcement to link that knowledge to action in the field. Further, monitoring exposes rule breakers to many unpleasant social consequences. Where there is no monitoring, even if sanctioning rules exist, they are not enforced because rule breakers cannot be caught (Coleman, 2009).

Drawing on the design principles, experiential knowledge, and recent research we suggest that in each village forest protection and management committee at least following mechanisms—with appropriate local innovations—should be ensured and should form part of VFPMC rule book:

1. Institutional arrangements (i.e., norms, rules and regulations which are locally made and enforced) in a

- VFPMC should be locally evolved and understood by each member. Good leadership and layered institutions should be identified to facilitate local rule making, local monitoring and local enforcement.
2. Technical interventions for livelihoods improvement through JFM should be locally explored and integrated in local resource management decisions. Possible ways for livelihoods improvement—employment, village development, sharing of goods, and sharing of service payments should be clearly mentioned in local management plans. Innovations such as payments for environmental services including ecotourism, watershed protection, carbon sequestration, biodiversity conservation that provide new avenue for livelihoods improvement should be integrated in local management planning.
 3. Clear and locally understood boundaries between legitimate users (members of VFPMC) and non-users (those who are not members of VFPMC) should be established. VFPMC should not only design local rules regarding who can become member and who can be excluded, these should also be made known to each member. Rules for the exclusion of non-members should be designed locally and clearly communicated to members of VFPMC concerned as well as to neighbouring VFPMC.
 4. The forests that are to be managed by a particular VFPMC should be well demarcated with clear boundaries that distinguish managed forest patch/area from a larger social-ecological system (various other resources in the village).
 5. The rules and management prescriptions for specific forests being managed by VFPMC should be coherent to both present condition and expected outcome of management.
- For example, rules framed to grow teak in Jaisalmer may clearly not be in coherence with local realities; instead, proposal to enrich landscape with *Rohira* and *Khejri* clearly are. Likewise, rules related to various restoration and management inputs should be congruent with local social and environmental conditions (for example, rather than thrusting a particular prescription on choice of species, within the limitation of climatic factors, grow what people want to grow).
6. Rules related to use and harvest of the resource should be congruent with rules related to various management inputs. In addition, the distribution of costs to members should be proportional to the distribution of benefits. Rights of VFPMC members to harvest forest produce and use the available services should be specifically granted and mentioned in the VFPMC records.
 7. Majority of individuals (members of VFPMC; both men and women) affected by a management prescription should be authorized to participate in making, modifying and enforcing the rules related to proposed prescriptions. Active presence of women in VFPMCs encourages enforcement, which is attributable especially to women's contributions to improved forest protection and rule compliance.
 8. Individuals who are accountable to or are the users (i.e., VFPMC members) should be authorized and encouraged to monitor the harvest and input levels of the other members. VFPMC should establish a transparent mechanism to enhance willingness of resource users to monitor one another's harvesting activities.
 9. VFPMC members (or their representatives in executive committee) should establish effective system for monitoring the condition of

- the regenerating forests, harvests and subsequent regeneration.
10. Penalty for violations of locally-designed rules should be very low for the first-time violators but become more stringent if a member repeatedly violates a rule.
 11. VFPMC should establish a mechanism, which should be rapid and low-cost, for resolving conflicts among members or with government officials. There should be a mechanism for stakeholders to maintain frequent face-to-face communication (such as frequent meetings, workshops, peer-to-peer learning sessions, resource and user monitoring). VFPMC should have a well-functioning system about how decisions made in these interactions are followed (for example, ways in which promises are kept or broken, or conflicts are resolved, or how rapidly officials provide assistance requested by VFPMC).
 12. Forest Department / Government should clearly recognize the rights of VFPMC members to make, monitor and enforce their own rules. Forest Department or any other Government Department should not impose external rules and enforcement prescriptions. Imposition of rules by external authorities, ignoring local rules and norms, is often fruitless and potentially detrimental to successful outcome. The long-term sustainability of rules designed at local level depends on monitoring and enforcement as well their not being overruled by larger government policies or government officials. For example, key indicators of existence of local enforcement are continuous learning about the social—ecological systems, rule compliance, patrolling, guarding against unauthorized use, graduated fines and sanctions in dealing with offenders.
 13. If forests being managed are closely connected to a larger social-ecological system, governance activities should be organized in multiple nested layers. For example, in a large forested landscape with many management regimes such as protected area, watershed protection, or community-managed forest etc. it may be necessary to establish institutional links and layers for appropriate management of larger landscape.
 14. Establishing a mechanism at VFPMC level for seamless application of scientific, experiential and indigenous knowledge to make the difference on the ground is necessary.
- Finally, we want to reiterate that in the ultimate analysis every VFPMC should establish credible and well-defined *local monitoring*, *local rule-making* and *local enforcement* system. Further, we also want to emphasize that autonomy of rule-making by VFPMC members—and not the government-imposed rules—is more robust predictor of both better forests as well as better availability of goods and services to support the livelihoods of local people. Village forest management and protection committees that do not have local rule-making, local monitoring and local enforcement systems are unlikely to succeed in their effort towards better forests and improved livelihoods.

ACKNOWLEDGEMENTS

We dedicate this paper to Professor Elinor Ostrom who has been awarded the Nobel Prize in Economic Sciences for the year 2009. We also thank Professor Ostrom for her illuminating comments on our question related to combined role of monitoring and adaptation. Insightful comments by Dr. Arun Agrawal (University of Michigan, USA), and Dr. Grant Milne, (the World Bank, Washington, DC) on an earlier version of this paper are gratefully acknowledged. The views expressed in this document are those of the author and not necessarily those of Government of Rajasthan or RSPCB.

ANNOTATED BIBLIOGRAPHY

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This is a review article. It is widely accepted that biodiversity loss and poverty are linked problems and that conservation and poverty reduction should be tackled together. However, success with integrated strategies is elusive. In most cases, hard choices will be necessary between goals, with significant costs to one goal or the other. One popular position is to argue that poverty is a critical constraint on conservation. This position makes the empirical, pragmatic argument that poverty limits conservation success to a sufficient degree that biodiversity conservation will fail if it does not successfully address poverty elimination. Such a position might be expected in a scenario where poor people were overharvesting wild species, poaching critical species, or colonizing and cultivating biodiverse land, and if the political or economic costs of stopping them (such as by a conventional strict protected-area strategy) were prohibitive. Beyond protected areas, the question of whether it is possible to combine poverty elimination and biodiversity conservation relates to the more general debate, familiar to conservation scientists, about the environmental dimensions of development. It is premature to abandon attempts to combine conservation and development. The elimination of poverty and the preservation of biodiversity are two distinct objectives. Each may be driven by different moral agendas, but there is considerable overlap in practice.

2. Agarwal, B. (2010). “**Does women’s proportional strength affect their participation? Governing local forests in South Asia.**” *World Development* **38**(1): 98-112.

Addressing the paucity of knowledge about how women’s proportional strength affects policy formulation, this paper, based on primary data for community forestry institutions in India and Nepal, statistically tests if a group’s gender composition affects women’s effective participation, and if there are any critical mass effects. The results support the popularly emphasized proportions of one-quarter to one-third, but women’s economic class also matters, as do some factors other than women’s numbers.

3. Agarwal, B. (2009). “**Rule making in community forestry institutions: The difference women make.**” *Ecological Economics*, **68**(8-9): 2296-2308.

Forest use rules determine what products are extracted from community governed forests, in what quantity, by what methods, and by whom. The nature of rules and the process by which they are formulated (e.g. who participates in formulating them) can impinge critically on institutional sustainability (given their potential impact on the commitment and incentive to protect), and on equity and conservation outcomes. This is well recognized in the substantial literature on institutions governing common pool resources (CPRs). It is also well recognized, although in relation to other types of institutions, such as legislatures and village councils, that there can be notable differences in women’s and men’s policy priorities. Yet there is surprisingly little existing work on, or statistical testing of, potential gender differences in rule making in institutions managing natural resources such as forests. This paper, based on the author’s primary data for India and Nepal, examines why we might expect women to favour different rules from men, and statistically tests whether the gender composition of the executive committees (ECs)—the main decision-making bodies of community forestry institutions (CFIs) in South Asia—makes a difference to the strictness of forest use rules.

Gender is found to make a significant difference to the rules specified but not always in the expected direction. Given their substantial and daily dependence on local forests, especially for firewood and fodder, rural women may normally be expected to veer toward lenient rules of extraction. In fact, groups with more EC women and especially with all-women ECs tend to make stricter rules than other groups in most of the sample districts, except one district where they tend to make less strict rules. Greater strictness is attributable especially to the resource constraint faced by all-women groups (ie. CFIs with all-women ECs) which receive smaller and more degraded forests than groups with men. Less strict rules among CFIs in the exceptional district are attributable especially to the disproportionate presence of landless women on their ECs. In other words, not simply women's presence in rule making but also their economic class can matter. Strictness also varies by type of product, forest and population characteristics, the EC's average age and dominant caste, and monitoring constraints.

4. Agarwal, B. (2009). "Gender and forest conservation: The impact of women's participation in community forest governance." *Ecological Economics* 68(11): 2785-2799.

Would enhancing women's presence in community institutions of forest governance improve resource conservation and regeneration? This paper focuses on this little addressed question. Based on the author's primary data on communities managing their local forests in parts of India and Nepal, it statistically assesses whether the gender composition of a local forest management group affects forest conservation outcomes, after controlling for other characteristics of the management group, aspects of institutional functioning, forest and population characteristics, and related factors. It is found that groups with a high proportion of women in their executive committee (EC)—the principal decision-making body—show significantly greater improvements in forest condition in both regions. Moreover, groups with all-women ECs in the Nepal sample have better forest regeneration and canopy growth than other groups, despite receiving much smaller and more degraded forests. Older EC members, especially older women, also make a particular difference, as does employing a guard. The beneficial impact of women's presence on conservation outcomes is attributable especially to women's contributions to improved forest protection and rule compliance. More opportunity for women to use their knowledge of plant species and methods of product extraction, as well as greater cooperation among women, are also likely contributory factors.

5. Agrawal, A. (2001). "Common property institutions and sustainable governance of resources." *World Development*, 29(10): 1649-1672.

This paper argues that the enterprise of generating lists of conditions under which commons are governed sustainably is a flawed and impossibly costly research task. For a way out, the paper examines the relative merits of statistical, comparative, and case study approaches to studying the commons. Careful research design and sample selection, construction of causal mechanisms, and a shift toward comparative and statistical rather than single-case analyses is suggested to be more useful. Such steps are necessary for a coherent, empirically-relevant theory of the commons.

6. Agrawal, A. and A. Chhatre (2006). "Explaining success on the commons: Community forest governance in the Indian Himalaya." *World Development*, 34(1): 149-166.

What explains the successful governance of commons? To answer this question, this paper addresses existing gaps in theory and knowledge by conducting a context-sensitive statistical analysis of 95 cases of decentralized, community-based, forest governance in Himachal Pradesh, and showing how a range of causal influences shape forest conditions in diverse ecological and institutional settings in the Indian Himalaya. In focusing attention on a large number of cases, but drawing on findings from case studies to motivate the analysis and choice of causal influences, this study combines the strengths of single case-oriented approaches and larger-N studies, and thereby contributes to a more thorough understanding of effective resource governance.

7. Agrawal, A., A. Chhatre and R. Hardin (2008). "Changing governance of the world's forests." *Science*, 320: 1460-1462.

Major features of contemporary forest governance include decentralization of forest management, logging concessions in publicly owned commercially valuable forests, and timber certification, primarily in temperate forests. Although a majority of forests continue to be owned formally by governments, the effectiveness of forest governance is increasingly independent of formal ownership. Growing and competing demands for food, biofuels, timber, and environmental services will pose severe challenges to effective forest governance in the future, especially in conjunction with the direct and indirect impacts of climate change. A greater role for community and market actors in forest governance and deeper attention to the factors that lead to effective governance, beyond ownership patterns, is necessary to address future forest governance challenges.

8. Andersson, K. P. (2004). “Who talks with whom? The role of repeated interactions in decentralized forest governance.” *World Development* 32(2): 233-249.

This article suggests that efforts to study decentralization outcomes would benefit from widening the unit of analysis from the local government administration to the local governance system. Many individual local governments, especially in developing countries, lack the human and physical resources to be effective governors by themselves. It is, thus, useful to recognize the linkages between different governance actors. The empirical analysis, based on observations in Bolivia’s forestry sector, finds that the degree of connectivity between the actors in a municipal governance system helps explain why some systems are more effective than others.

9. Andersson, K. and E. Ostrom (2008). “Analyzing decentralized resource regimes from a polycentric perspective.” *Policy Sciences* 41(1): 71-93.

This article seeks to shed new light on the study of decentralized natural resource governance by applying institutional theories of polycentricity—the relationships among multiple authorities with overlapping jurisdictions. The emphasis on multi-level dynamics has not penetrated empirical studies of environmental policy reforms in non-industrial countries. On the contrary, many of today’s decentralization proponents seem to be infatuated with the local sphere, expecting that local actors are always able and willing to govern their natural resources effectively. Existing studies in this area often focus exclusively on characteristics and performance of local institutions. While authors certainly do not deny the importance of local institutions, they argue that institutional arrangements operating at other governance scales—such as national government agencies, international organizations, NGOs at multiple scales, and private associations—also often have critical roles to play in natural resource governance regimes, including self-organized regimes.

10. Baland, J. M. and J. P. Platteau (1996). “Halting Degradation of Natural Resources: Is There a Role for Rural Communities.” Food and Agriculture Organization of the United Nations, Rome. Available at: <http://www.fao.org/docrep/x5316e/x5316e00.htm>

The present work is concerned with the topical issue of natural resource management that focuses on local ecosystems. When tackling the question as how best to manage local commons or village-level resources, it has become common practice in many writings to distinguish between three modes of management: private, public (or state), and community management. It has often been claimed that the tragedy of the commons could be easily solved by simply establishing private property rights on the resource. This book takes a balanced view of the various implications of privatization of the commons. It is argued that, even on the basis of the strict criterion of efficiency, privatization of natural resources is not always an appropriate solution. In the concluding section, authors bring into focus what they consider to be the most salient findings or propositions of the study and to draw the policy implications therefrom. Comparative studies, given in the book, of rules used in long-surviving resource systems governed by traditional societies document the wide diversity of rules used across sectors and regions of the world.

11. Baland, J.-M., P. Bardhan, S. Das and D. Mookherjee (2010). “Forests to the people:

Decentralization and forest degradation in the Indian Himalayas.” *World Development* 38(11): 1642-1656.

This paper assesses degradation of forests managed by local communities (Van Panchayats (VPs)), relative to state protected and open access forests in Uttaranchal. It is based on ground-level ecological measures of forest quality (including canopy cover, biomass, lopping, and regeneration) in forest areas adjoining a random sample of villages, and controls for unobserved village heterogeneity, possible endogeneity of management regimes and cross-forest spillovers. Controlling for these factors, VP forests are found to be 20-30% less lopped, and similar on other dimensions. The lopping differences are greater the longer the forest has been under a VP.

12. Behera, B. (2009). “Explaining the performance of state–community joint forest management in India.” *Ecological Economics*, 69(1): 177-185.

This paper seeks to identify and analyze the factors that explain differential outcomes of joint forest management (JFM) in the Indian state of Andhra Pradesh. Factors affecting the performances of JFM communities are analyzed using an ordered logit model. The results indicate that JFM communities are more likely to perform well when they are smaller in size and when forest resources in the JFM community are scarce. Presence of social capital and high value forests are also likely to promote good forest growth. Effective protection of forests is likely to contribute to the growth of forests. JFM communities that were initiated by NGOs are more likely to manage forests effectively than the one initiated by the Forest Department.

13. Benayas, J. M. R., A. C. Newton, A. Diaz and J. M. Bullock (2009). “Enhancement of biodiversity and ecosystem services by ecological restoration: A meta-analysis.” *Science* 325: 1121-1124.

Ecological restoration is widely used to reverse the environmental degradation caused by human activities. However, the effectiveness of restoration actions in increasing provision of both biodiversity and ecosystem services has not been evaluated systematically. A meta-analysis of 89 restoration assessments in a wide range of ecosystem types across the globe indicates that ecological restoration increased provision of biodiversity and ecosystem services by 44 and 25%, respectively. However, values of both remained lower in restored versus intact reference ecosystems. Increases in biodiversity and ecosystem service measures after restoration were positively correlated. Results indicate that restoration actions focused on enhancing biodiversity should support increased provision of ecosystem services, particularly in tropical terrestrial biomes.

14. Berkes, F. (2007). “Community-based conservation in a globalized world.” *Proceedings of the National Academy of Sciences* 104(39): 15188-15193.

Communities have an important role to play in biodiversity conservation. However, community-based conservation as a panacea, like government-based conservation as a panacea, ignores the necessity of managing commons at multiple levels, with vertical and horizontal interplay among institutions. The study of conservation in a multilevel world can serve to inform an interdisciplinary science of conservation, consistent with the Convention on Biological Diversity, to establish partnerships and link biological conservation objectives with local development objectives. Improving the integration of conservation and development requires rethinking conservation by using a complexity perspective and the ability to deal with multiple objectives, use of partnerships and deliberative processes, and learning from commons research to develop diagnostic tools. Perceived this way, community-based conservation has a role to play in a broad pluralistic approach to biodiversity protection: it is governance that starts from the ground up and involves networks and linkages across various levels of organization. The shift of attention to processes at multiple levels fundamentally alters the way in which the governance of conservation development may be conceived and developed, using diagnostics within a pluralistic framework rather than a blueprint approach.

15. Berkes, F., J. Colding and C. Folke (2000). “Rediscovery of traditional ecological knowledge

as adaptive management.” *Ecological Applications* **10**(5): 1251-1262.

Indigenous groups offer alternative knowledge and perspectives based on their own locally developed practices of resource use. Authors surveyed the international literature to focus on the role of Traditional Ecological Knowledge in monitoring, responding to, and managing ecosystem processes and functions, with special attention to ecological resilience. Case studies revealed that there exists a diversity of local or traditional practices for ecosystem management. These include multiple species management, resource rotation, succession management, landscape patchiness management, and other ways of responding to and managing pulses and ecological surprises. Social mechanisms behind these traditional practices include a number of adaptations for the generation, accumulation, and transmission of knowledge; the use of local institutions to provide leaders/stewards and rules for social regulation; mechanisms for cultural internalization of traditional practices; and the development of appropriate world views and cultural values. Some traditional knowledge and management systems were characterized by the use of local ecological knowledge to interpret and respond to feedbacks from the environment to guide the direction of resource management. These traditional systems had certain similarities to adaptive management with its emphasis on feedback learning, and its treatment of uncertainty and unpredictability intrinsic to all ecosystems.

16. Bhattacharya, P., L. Pradhan and G. Yadav (2010). “**Joint forest management in India: Experiences of two decades.**” *Resources, Conservation and Recycling* **54**(8): 469-480.

This review notes that JFM has emerged over the past decades both as a specific paradigm of forest governance in India and as India’s largest community forestry program. The JFM program is implemented currently by 106,482 Joint Forest Management Committees (JFMC) and covers 22 million ha of forests spread across 28 States of India and union territories. Thirty years from its inception, there are now concerns for the recent effectiveness of JFM (over the past 20 years) because it is a group action that is getting old and is perhaps losing some of its pioneering drive and innovativeness. The current paper seeks to provide a stock-taking review and analysis. The paper highlights design and implementation issues related to government resolutions, benefits-sharing and forest offences. It also assesses the critical design factors and key drivers responsible for institutional reforms. The paper evaluates impacts of protection on forest productivity and on the livelihoods of local communities. It highlights that the JFM program, by virtue of the diversity of its implementation, provides an ideal laboratory for exploring why similar reforms can lead to different outcomes. The paper argued that though there are supporting government policy and guideline and massive fund support, why there has been a low down of enthusiasm for JFM in the last two decades. From experiences, it suggests strategies for its revival and JFM can further contribute effective toward forest conservation and enhanced livelihood opportunities in the future.

17. Brock, W. A. and S. R. Carpenter (2007). “**Panaceas and diversification of environmental policy.**” *Proceedings of the National Academy of Sciences* **104**(39): 15206-15211.

Authors consider panacea formation in the framework of adaptive learning and decision for social–ecological systems (SESs). Institutions for managing such systems must address multiple timescales of ecological change, as well as features of the social community in which the ecosystem policy problem is embedded. Response of the SES to each candidate institution must be modeled and treated as a stochastic process with unknown parameters to be estimated. A fundamental challenge is to design institutions that are not vulnerable to capture by subsets of the community that self-organize to direct the institution against the overall social interest. In a world of episodic structural change, such as SESs, adaptive learning can lock in to a single institution, model, or parameter estimate. Policy diversification, leading to escape from panacea traps, can come from monitoring indicators of episodic change on slow timescales, minimax regret decision making, active experimentation to accelerate model identification, mechanisms for broadening the set of models or institutions under consideration, and processes for discovery of new institutions and technologies for ecosystem

management. It is difficult to take all of these factors into account, but the discipline that comes with the attempt to model the coupled social–ecological dynamics forces policy makers to confront all conceivable responses. This process helps induce the modesty needed to avoid panacea traps while supporting systematic effort to improve resource management in the public interest.

18. Canadell, J. G. and M. R. Raupach (2008). “**Managing forests for climate change mitigation.**” *Science* **320**: 1456-1457.

Forests currently absorb billions of tons of CO₂ globally every year, an economic subsidy worth hundreds of billions of dollars if an equivalent sink had to be created in other ways. Concerns about the permanency of forest carbon stocks, difficulties in quantifying stock changes, and the threat of environmental and socioeconomic impacts of large-scale reforestation programs have limited the uptake of forestry activities in climate policies. With political will and the involvement of tropical regions, forests can contribute to climate change protection through carbon sequestration as well as offering economic, environmental, and sociocultural benefits. A key opportunity in tropical regions is the reduction of carbon emissions from deforestation and degradation.

19. Chakrabarti, M. and S. K. Datta (2009). “**Evolving an effective management information system to monitor co-management of forests.**” *Economic and Political Weekly* **44**(18): 53-60.

The failure of the Joint Forest Management programme since 2000 to sustain the growth in afforestation achieved during the 1990s is a cause for concern. This paper looks at the necessity of developing an effective management information system that can contribute meaningfully to the resilience of a jfm system. Identifying four scenarios that differ in terms of the relative contribution of the community and the State in the management process, it offers a schematic structure of an MIS.

20. Chazdon, R. L. (2008). “**Beyond deforestation: Restoring forests and ecosystem services on degraded lands.**” *Science* **320**: 1458-1460.

Despite continued forest conversion and degradation, forest cover is increasing in countries across the globe. New forests are regenerating on former agricultural land, and forest plantations are being established for commercial and restoration purposes. Plantations and restored forests can improve ecosystem services and enhance biodiversity conservation, but will not match the composition and structure of the original forest cover. Approaches to restoring forest ecosystems depend strongly on levels of forest and soil degradation, residual vegetation, and desired restoration outcomes. Opportunities abound to combine ambitious forest restoration and regeneration goals with sustainable rural livelihoods and community participation. New forests will require adaptive management as dynamic, resilient systems that can withstand stresses of climate change, habitat fragmentation, and other anthropogenic effects.

21. Chhatre, A. and A. Agrawal (2008). “**Forest commons and local enforcement.**” *Proceedings of the National Academy of Sciences*, **105**(36): 13286-13291.

This research examines the relationship between local enforcement and forests used as commons. Higher levels of local enforcement have a strong and positive but complex relationship to the probability of forest regeneration. This relationship holds even when the influence of a number of other factors such as user group size, subsistence, and commercial importance of forests, size of forest, and collective action for forest improvement activities is taken into account. Although several of the above factors have a statistically significant relationship to changes in the condition of forest commons, differences in levels of local enforcement strongly moderate their link with forest commons outcomes.

22. Chhatre, A. and A. Agrawal (2009). “**Trade-offs and synergies between carbon storage and livelihood benefits from forest commons.**” *Proceedings of the National Academy of Sciences*, **106** (42): 17667-17670.

By using original data on 80 forest commons in 10 countries across Asia, Africa, and Latin America, authors show that larger forest size and greater rule-making autonomy at the local level are associated with high carbon storage and livelihood benefits; differences in ownership of forest commons are associated with trade-offs between livelihood benefits and carbon storage. It has been argued that local communities restrict their consumption of forest products when they own forest commons, thereby increasing carbon storage. In showing rule-making autonomy and ownership as distinct and important institutional influences on forest outcomes, these results are directly relevant to international climate change mitigation initiatives such as Reduced Emissions from Deforestation and Forest Degradation (REDD) and avoided deforestation. It is noted that transfer of ownership over larger forest commons patches to local communities, coupled with payments for improved carbon storage can contribute to climate change mitigation without adversely affecting local livelihoods.

23. Coleman, E. A. and B. C. Steed (2009). “**Monitoring and sanctioning in the commons: An application to forestry.**” *Ecological Economics*, **68**(7): 2106-2113.

This research examines theoretical determinants of monitoring and sanctioning at both the local community level and from external government agents using the Institutional Analysis and Development (IAD) framework. Paper then estimates a bivariate probit statistical model to test the theory using data from 100 forests in 14 countries collected by the International Forestry Resources and Institutions (IFRI) research program. Among other things, authors find that a right to harvest some portion of the resource is an important determinant of local monitoring and sanctioning. The number of external aid agencies and NGOs is an important determinant of external monitoring and sanctioning.

24. Coleman, E. A. (2009). “**Institutional factors affecting biophysical outcomes in forest management.**” *Journal of Policy Analysis and Management* **28**(1): 122-146.

Although there is considerable interest in the impact of diverse policies affecting the biophysical outcomes in forests, gaining a substantial sample over time of forests under different institutional arrangements has been difficult. This article analyzes data from 46 forests located in six countries over time. In forests where policies have been adopted for conservation, active monitoring and sanctioning by locals is associated with positive forest conditions. Forests that allow user group harvesting, perhaps counterintuitively, are also shown to be associated with positive forest conditions. However, conditions in community-managed forests are not statistically different from government- or privately managed forests. This implies that local communities can play an important role in achieving positive forest conditions but that full management responsibilities need not be given to achieve these results.

25. Cox, Michael, Gwen Arnold, and Sergio Villamayor-Tomás (2010). “**A review and reassessment of design principles for community-based natural resource management.**” submitted to *Ecology and Society*. (mentioned by Elinor Ostrom in her Nobel Lecture, 2009, “**Beyond Markets and States: Polycentric Governance of Complex Economic Systems**” available at http://nobelprize.org/nobel_prizes/economics/laureates/2009/ostrom-lecture-slides.pdf).

In 1990, Elinor Ostrom proposed eight design principles, positing them to characterize robust institutions for managing common-pool resources such as forests or fisheries. Since then, a large amount of literature has been written that explicitly or implicitly evaluates these design principles, but no effort has been made to systematically evaluate these studies in order to perform a reassessment that takes this new knowledge into account. This paper evaluates 96 such studies in order to evaluate the principles empirically and to consider what theoretical issues have arisen since their introduction. authors find that there are several important theoretical issues that warrant a discussion, and that the principles are well supported empirically. The paper concludes with a reformulation of the design principles, drawing from commonalities found in the studies.

26. Dietz, T, E. Ostrom and P. C Stern (2003). “**The struggle to govern the commons.**” *Science*, **302**:

1907-1912.

Human institutions—ways of organizing activities—affect the resilience of the environment. Locally evolved institutional arrangements governed by stable communities and buffered from outside forces have sustained resources successfully for centuries, although they often fail when rapid change occurs. Ideal conditions for governance are increasingly rare. Critical problems, such as transboundary pollution, tropical deforestation, and climate change, are at larger scales and involve non-local influences. Promising strategies for addressing these problems include dialogue among interested parties, officials, and scientists; complex, redundant, and layered institutions; a mix of institutional types; and designs that facilitate experimentation, learning, and change. Sound science is necessary for commons governance, but not sufficient. Too many strategies for governance of local commons are designed in capital cities or by donor agencies in ignorance of the state of the science and local conditions. The results are often tragic, but at least these tragedies are local.

27. Fleischman, F. (2009). “**Informal institutions and enforcement of forest rules.**” POLS Y673: Networks and Institutions.

In this paper author has shown how a relational perspective can be used to understand the relationship between forest users and forests. It is also shown that forest rule enforcement has a strong positive relationship with formal user organization, the ability of users to make rules, and their experience of monitoring and sanctioning outside of the forest, while it does not have a clear relationship with government ownership, resource dependence, or group size. This paper represents a first attempt to develop these ideas.

28. Gavin, M. C., J. N. Solomon and S. G. Blank (2010). “**Measuring and monitoring illegal use of natural resources.**” *Conservation Biology* 24(1): 89 - 100.

Illegal use of natural resources is a threat to biodiversity globally, but research on illegal activities has methodological challenges. Authors examined 100 studies that empirically identify targeted resources, techniques used to procure resources illegally, locations of illegal activities, characteristics of typical violators, incentives driving illegal use of resources, magnitude of the problem of illegal use (e.g., quantities used), or frequency of illegal activity. The evaluation also explores methods used in these studies on their ability to provide these empirical data, relative labor demands, training and technology requirements, and levels of uncontrollable bias. Eight different methods were evaluated: law-enforcement records, indirect observation, self-reporting, direct observation, direct questioning, randomized response technique (a survey method designed to improve accuracy of responses to sensitive questions), forensics, and modeling. Different situations favored different methods, each with distinct advantages and limitations. Six context-specific factors—location of resource use (in situ vs. ex situ), budget, technology and training capacity, ease of detection of illegal activity, scope of illegal activity (limited vs. widespread), and researchers’ willingness to accept bias in results—help narrow the choice of methods. Several methodological concerns applied to any study of illegal resource use: regular monitoring can detect trends; modeling can incorporate sampling error and data uncertainties; researchers must manage levels of bias that vary between methods; triangulation of results from multiple methods can improve accuracy. No method is a panacea, but a combination of techniques can help address the lack of data on illegal activity. Researchers empirically compared results from different methods in only four studies, and no one has compared more than two methods simultaneously. Conservation would benefit from more research focused on: methods comparisons that include cost effectiveness, time efficiency, and statistical rigor; unique applications of the eight techniques currently in use; and testing of new methods

29. Ghose, Abhijit (1996). “**Sustainability of joint forest management in India.**” *Social Action*, 26(1): 84-98.

The paper argues that even if there is a conducive social, economic, technical and managerial set up, JFM cannot succeed without proper institutional support. True success of JFM is unthinkable

without strengthening the people's institutions as these institutions actually need to play the active role where as both the GOs and NGOs are having more of passive or catalytic role. Role of monitoring is also emphasized.

30. Ghate, R. and H. Nagendra (2005). “**Role of monitoring in institutional performance: Forest management in Maharashtra, India.**” *Conservation & Society* 3(2): 509–532.

This research article examined the role of ‘monitoring’ for effective participatory common property management and examined the three most frequent approaches in India, namely community-initiated management, non-governmental organization (NGO) promoted forest management, and state-sponsored Joint Forest Management (JFM). Study was undertaken in the three communities of Gadchiroli district. Findings of the study indicate that local enforcement has been most effective in the case where forest management was initiated by the community, with better regeneration, and negligible evidence of grazing and fire. Inefficient monitoring was apparent in the state-initiated JFM village, with uncontrolled grazing and fire, leading to heavy damage to the forest. In the third case, with NGO-promoted forest management, greater importance was given to protecting the resource from outsiders, while neglecting the overuse of forest products by the community members. The perception of scarcity of forest resource appears a crucial factor motivating the community to organize and protect the forest. The impact of strict monitoring, sanctioning and protection is paying rich dividends and is an indicator of a dense, successfully regenerated and healthy forest for the future. Monitoring is a must for the long-term sustainability of the initiative. Monitoring is essential to ensure rule compliance by community members, as well as protection from poaching by outsiders, in order to ensure effective management of degraded and dense forests. The impact of monitoring by communities depends critically on the state of the forest at the time of handing over of management to communities and incentive plays an important role for community to protect the resource apart from creating awareness. Thus, results indicate the need for a proactive role by the state both in supporting community initiated forest protection efforts and in motivating the communities for participation in such efforts. NGOs can play a useful role in catalysing this process, and encouraging coordination between the protection efforts of the communities and the Forest Department.

31. Gibson, C. C., J. T. Williams and E. Ostrom (2005). “**Local enforcement and better forests.**” *World Development*, 33(2): 273-284.

This research article provides a very important point about monitoring. Based on the analysis of the International Forestry Resources and Institutions (IFRI) data, this research finds that it is highly unlikely for forest condition to be good if there is no monitoring and rule enforcement regardless of whether social capital of stakeholders is high or low. Likewise, better forest outcome is also associated with rule enforcement (i.e. adaptations based on the insights through local monitoring) regardless of the degree of formal organization of the stakeholders. And finally, better monitoring and local rule enforcement is also significantly associated with better forest condition, regardless of whether or not a group's dependence on the forests is light or heavy.

32. Hardin, G. (1968). “**The tragedy of the commons.**” *Science* 162(3859): 1243-1248.

In this seminal paper, author argued that the population problem has no technical solution; it requires a fundamental extension in morality. Perhaps the simplest summary of this analysis of man's population problems is this: the commons, if justifiable at all, is justifiable only under conditions of low-population density. As the human population has increased, the commons has had to be abandoned in one aspect after another. The key message of the paper relevant to forestry was that forest users will never self-organize to maintain their resources and that the common property, such as forests, should either be privatized or governments must impose control.

33. Hayes, T. and L. Persha (2010). “**Nesting local forestry initiatives: Revisiting community forest management in a REDD+ world.**” *Forest Policy and Economics*, 12(8): 545-553.

Rule making autonomy by local forest users is important for forest conservation. However, local institutions also face governance challenges from external sources. Independent external organizations may usefully mediate these challenges. A recent synthesis suggests that successful sustained forest management depends on institutional arrangements that (1) establish local resident rulemaking autonomy, (2) facilitate the flow of external financial and institutional assistance for monitoring and enforcement of local rules, and (3) buffer residents and their respective local institutions from more powerful, and at times corrupt, actors and agencies involved in forest exploitation. The results particularly suggest a role for external, independent non-governmental organizations to help mediate demands on local forest governance systems in nested contexts.

34. Hilborn, R., P. Arcese, M. Borner, J. Hando, G. Hopcraft, M. Loibooki, S. Mduma and A. R. E. Sinclair (2006). “**Effective enforcement in a conservation area.**” *Science*, **314**:1266.

Wildlife within protected areas is under increasing threat from bushmeat and illegal trophy trades, and many argue that enforcement within protected areas is not sufficient to protect wildlife. Authors examined 50 years of records from Serengeti National Park in Tanzania and calculated the history of illegal harvest and enforcement by park authorities. It is shown that a precipitous decline in enforcement in 1977 resulted in a large increase in poaching and decline of many species. Conversely, expanded budgets and antipoaching patrols since the mid-1980s have greatly reduced poaching and allowed populations of buffalo, elephants, and rhinoceros to rebuild.

35. Hobley, M. and K. Shah (1996). **What makes a local organisation robust? Evidence from India and Nepal.** ODI Natural Resource Perspectives, No. 11, Overseas Development Institute (ODI), London, UK, pp.

The move towards decentralisation of resource control and management promises more efficient, equitable and sustainable resource use. Debate centres on what type of institutional arrangement in a given context is most appropriate and will lead to the fulfilment of the above ideal. Aspects of these arrangements include property rights structures as well as organisational structures. Following two decades of experience in India and Nepal with development of local forest management organisations, this paper analyses the factors that contribute to the effectiveness of local organisations as resource managers. It outlines gaps in our knowledge and concludes with a discussion of the implications for policy and practice. Policy conclusions of the paper are: Enabling policy frameworks are essential to legitimise innovative support by forest staff of village resource management and allow local people to assert traditional rights to resources they have protected; Multi-agency approaches (village/NGO/government/political) are necessary to provide effective support to local organisations and to facilitate change in government, but are often hampered by limited commitment to change; The usual dichotomy between public and private resource management is crude: more realistic is the concept of a continuum of different organisational and property rights relationships according to the nature of the resource to be managed; There are important trade-offs between environmental protection and poverty: the rights of the poor are particularly threatened as access is limited in the recuperation phase, and subsequently as the value of the resource increases; For successful local management a protected resource has to yield both short and long-term benefits and have agreed social and physical boundaries; Local voice in the modification of rules is an important characteristic of robust resource management organizations; Externally-supported projects which focus on disbursement at the expense of comprehensive surveys of traditional rights and responsibilities are unlikely to succeed.

36. Janssen, M. A., R. Holahan, A. Lee and E. Ostrom (2010). “**Lab experiments for the study of social-ecological systems.**” *Science* **328**(5978): 613-617.

Governance of social-ecological systems is a major policy problem of the contemporary era. Field studies of fisheries, forests, and pastoral and water resources have identified many variables that influence the outcomes of governance efforts. This paper introduces an experimental environment that involves spatial and temporal resource dynamics in order to capture these two critical variables

identified in field research. These experiments confirm that participants will use costly punishment, but the use of punishment without communication does not increase gross payoffs. When communication among stakeholders is allowed, the performance of the group increases significantly. The performance is not sustained when punishment is used and communication is no longer possible. These results stress the importance of communication in solving the dilemmas of management of commons.

37. Kashwan, P. (2006). “**Why Harda failed.**” *Economic and Political Weekly* **41**(24): 2497-2499.

Arguing that the bargaining power of donors has weakened because of strong economic development registered by India, author suggests that Madhya Pradesh, endowed with one of the best forest resources in the country managed by a strong bureaucracy, is a particularly difficult target for the donors. The root causes of the failure of participatory forest management need to be understood carefully. Discussions of the existing research on community-forest-state relations suggests that it is neither sufficient nor useful to treat the conflicts in forest management, such as the one witnessed in Harda, as being an outcome of difference of perceptions between different stakeholders. In fact, the conflicts and poor outcomes of participatory forestry projects such as the Harda model are reflective of the larger issues concerning democratization, and the development policies pursued by the state. The article also argues that contrary to the much publicized successes on human development front achieved by the Madhya Pradesh government, recent research has shown a systematic exclusion of scheduled tribes and scheduled castes from accessing development gains.

38. Lamb, D., P. D. Erskine and J. A. Parrotta (2005). “**Restoration of degraded tropical forest landscapes.**” *Science* **310**: 1628-1632.

The current scale of deforestation in tropical regions and the large areas of degraded lands now present underscore the urgent need for interventions to restore biodiversity, ecological functioning, and the supply of goods and ecological services previously used by poor rural communities. Traditional timber plantations have supplied some goods but have made only minor contributions to fulfilling most of these other objectives. New approaches to reforestation are now emerging, with potential for both overcoming forest degradation and addressing rural poverty.

39. Milne, G., B. Verardo and R. Gupta (2006). *India: Unlocking Opportunities for Forest-Dependent People in India*. The World Bank/ Oxford University Press, New Delhi.

This World Bank study estimated that for the area presently under JFM alone, total forest income from commercial timber, bamboo and non-timber products on improved forests could rise from an estimated US\$222 million in 2004 to approximately US\$2 billion per annum in 2020 based on modest assumptions about forest productivity gains and commercial output from community forests. Further, with modest value addition and quality enhancements, annual commercial incomes could increase by another US\$220 million in 2020. Many communities could easily earn up to Rs1 million or more in cash income each year using existing technology and simple forest management options without compromising forest sustainability and the multiple values associated with forest resources. Given improved technology, higher quality seed and seedlings, and better market access, many communities could develop value-added activities that could generate even greater returns to sustain forest management and provide funds for rural development needs. Communities would continue to enjoy subsistence benefits from the forest; the net value of domestic fuelwood and fodder could be worth another US\$1.1 billion per annum. Ecological and eco-tourism values from current JFM forests could be as high as US\$1.7 billion as these forests mature and begin to generate conservation benefits.

40. Nagendra, H. (2007). “**Drivers of reforestation in human-dominated forests.**” *Proceedings of the National Academy of Sciences*, **104**: 15218-15223.

Tropical forest habitat continues to decline globally, with serious negative consequences for environmental sustainability. The small mountain country of Nepal provides an excellent context in which to examine trajectories of forest-cover change. Despite having experienced large-scale forest

clearing in the past, significant reforestation has taken place in recent years. The range of biophysical and ecological environments and diversity of tenure arrangements provide us with a context with sufficient variation to be able to derive insight into the impact of a range of hypothesized drivers of forest change. This article draws on a dataset of 55 forests from the middle hills and Terai plains of Nepal to examine the factors associated with forest clearing or regeneration. Results affirm the central importance of tenure regimes and local monitoring for forest regrowth. In addition, user group size per unit of forest area is an important, independent explanator of forest change. These variables also can be associated with specific practices that further influence forest change such as the management of social conflict, adoption of new technologies to reduce pressure on the forest, and involvement of users in forest maintenance activities. Such large-N, comparative studies are essential if we are to derive more complex, nuanced, yet actionable frameworks that help us to plan better policies for the management of natural resources.

41. Nagendra, H. (2010). “Reforestation and regrowth in the human dominated landscapes of south Asia.” In: H. Nagendra and J. Southworth (eds.), *Reforesting Landscapes: Linking Pattern and Process*. Springer Netherlands, pp. 149-174.

Of the six countries in South Asia, four – Bangladesh, Bhutan, India and Nepal – have experienced increases in forest area and/or in forest density, which cannot be directly attributed to commonly identified drivers of forest change, such as changes in population density, affluence, or development. This meta-analysis of 24 case studies finds that the dominant pathway to reforestation in South Asia appears to be that of protection and planting of trees in degraded forests. A second, commonly encountered pathway is farm agroforestry, leading to increased tree cover on privately owned lands. Reforestation on abandoned unproductive lands does not appear to be significant in South Asia. Further, an in-depth study of four landscapes located in India and Nepal provides greater insight into the human drivers of reforestation and regrowth. Taken together, these analyses indicate that the commitment of national governments towards protection and the devolution of forest management to local communities have been critical in facilitating reforestation in this region.

42. Nagendra, H. (2009). “Drivers of regrowth in South Asia’s human impacted forests.” *Current Science* **97**(11): 1586-1592.

While loss of forest cover continues to represent a serious environmental challenge, significant reforestation is taking place in many parts of the world. This article assesses the institutional factors that impact forest management in developing countries, with a focus on Nepal and India. Research methods link empirical results obtained from multiple methods in multiple field settings at different temporal and spatial scales to look at the human drivers of forest cover change across a range of social-ecological contexts. The legitimacy of ownership, degree of monitoring, density of forest users, and the flexibility to adapt to changing conditions appear critical factors, although the official designation of a forest tenure regime does not appear to be as important.

43. Nagendra, H. and Y. Gokhale (2008). “Management regimes, property rights, and forest biodiversity in Nepal and India.” *Environmental Management*, **41**(5): 719-733.

This article compares a range of initiatives aimed at involving people in the management of forest resources in Nepal and India. In Nepal, authors focus on three categories of state-initiated programs: community forestry, the parks’ buffer zone program, and leasehold forestry. In the southern Indian state of Karnataka, they study the state-initiated Joint Forest Planning and Management program along with older institutions of leaf manure forests (Soppina betta) and historical sacred forests (Kans). It is concluded that state-initiated approaches to involving communities have been limited, at best, promote standardized and relatively inflexible management practices, and lead to partial improvement in biodiversity and people’s livelihoods. When management is initiated and owned by the community, as in the case of sacred groves in India, and when other conditions are appropriate, communities can have the opportunity to demonstrate their capacity for putting effective

and adaptive conservation practices in place.

44. Ostrom, E. (1990). *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge, UK, Cambridge University Press.

The governance of natural resources used by many individuals in common is an issue of increasing concern to policy analysts. Both state control and privatization of resources have been advocated, but neither the state nor the market have been uniformly successful in solving common pool resource problems. After critiquing the foundations of policy analysis as applied to natural resources, Elinor Ostrom here provides a unique body of empirical data to explore conditions under which common pool resource problems have been satisfactorily or unsatisfactorily solved. Author first describes three models most frequently used as the foundation for recommending state or market solutions. She then outlines theoretical and empirical alternatives to these models in order to illustrate the diversity of possible solutions. She uses institutional analysis to examine different ways—both successful and unsuccessful—of governing the commons. In contrast to the proposition of the tragedy of the commons argument, common pool problems sometimes are solved by voluntary organizations rather than by a coercive state.

45. Ostrom, E. (1999). *Self-Governance and Forest Resources*. CIFOR Occasional Paper No. 20. Bogor, Indonesia, CIFOR. 15 p.

Destruction or degradation of forest resources is most likely to occur in open-access forests where those involved, or external authorities, have not established effective governance. Conventional theories applied to forest resources presumed that forest users themselves were incapable of organizing to overcome the temptations to overharvest. Extensive empirical research, however, has challenged this theory and illustrated the many ways that forest users themselves have devised rules that regulate harvesting patterns so as to ensure the sustainability of forest resources over time. There is now a large body of literature analysing common-pool resources such as many fisheries, irrigation systems and rangelands. A growing consensus exists in this literature concerning the attributes of common-pool resources and of resource users that enhance the probability that self-organization will occur. Many of these attributes seem also to help predict when forest users will self-organize. Forest users are more likely to devise their own rules when they use a forest that is starting to deteriorate but has not substantially disappeared, when some forest products provide early warning concerning forest conditions, when forest products are predictably available, and when the forest is sufficiently small that users can develop accurate knowledge of conditions. Self-organization is more likely to occur when forest resources are highly salient to users, and when users have a common understanding of the problems they face, have a low discount rate, trust one another, have autonomy to make some of their own rules, and have prior organizational experience. These attributes of forests and of the user community affect the benefits and costs of organizing to protect and enhance forest resources. When users create organizations consistent with a set of design principles, they are likely to be able to sustain their own institutional arrangements over a long period of time.

46. Ostrom, E. (1999). “Coping with tragedies of the commons.” *Annual Review of Political Science*, 2(1): 493-535.

Contemporary policy analysis of the governance of common-pool resources is based on three core assumptions: (a) resource users are norm-free maximizers of immediate gains, who will not cooperate to overcome the commons dilemmas they face; (b) designing rules to change incentives of participants is a relatively simple analytical task; and (c) organization itself requires central direction. The chapter shows that these assumptions are a poor foundation for policy analysis. Findings from carefully controlled laboratory experiments that challenge the first assumption are summarized. A different assumption that humans are fallible, boundedly rational, and norm-using is adopted. The complexity of using rules as tools to change the structure of commons dilemmas is then discussed, drawing on extensive research on rules in field settings. Viewing all policies as experiments with a

probability of failure, recent research on a different form of general organization—that of complex adaptive systems—is applied to the process of changing rules. The last sections examine the capabilities and limits of a series of completely independent resource governance systems and the importance of encouraging the evolution of polycentric governance systems.

47. Ostrom, E. (2007). “**A diagnostic approach for going beyond panaceas.**” *Proceedings of the National Academy of Sciences*, **104**(39): 15181-15187.

The articles in this special feature challenge the presumption that scholars can make simple, predictive models of social–ecological systems (SESs) and deduce universal solutions, panaceas, to problems of overuse or destruction of resources. Moving beyond panaceas to develop cumulative capacities to diagnose the problems and potentialities of linked SESs requires serious study of complex, multivariable, nonlinear, cross-scale, and changing systems. Many variables have been identified by researchers as affecting the patterns of interactions and outcomes observed in empirical studies of SESs. A step toward developing a diagnostic method is taken by organizing these variables in a nested, multitier framework. The framework enables scholars to organize analyses of how attributes of (i) a resource system (e.g., fishery, lake, grazing area), (ii) the resource units generated by that system (e.g., fish, water, fodder), (iii) the users of that system, and (iv) the governance system jointly affect and are indirectly affected by interactions and resulting outcomes achieved at a particular time and place. The framework also enables us to organize how these attributes may affect and be affected by larger socioeconomic, political, and ecological settings in which they are embedded, as well as smaller ones. The framework is intended to be a step toward building a strong interdisciplinary science of complex, multilevel systems that will enable future diagnosticians to match governance arrangements to specific problems embedded in a social–ecological context.

48. Ostrom, E. (2009). “**A general framework for analyzing sustainability of social-ecological systems.**” *Science*, **325**: 419-422.

A general framework is provided here to identify subsystem variables that affect the likelihood of self-organization in efforts to achieve a sustainable SES. The subsystems are (i) resource systems (e.g., a designated protected park encompassing a specified territory containing forested areas, wildlife, and water systems); (ii) resource units (e.g., trees, shrubs, and plants contained in the park, types of wildlife, and amount and flow of water); (iii) governance systems (e.g., the government and other organizations that manage the park, the specific rules related to the use of the park, and how these rules are made); and (iv) users (e.g., individuals who use the park in diverse ways for sustenance, recreation, or commercial purposes). Each core subsystem is made up of multiple second-level variables (e.g., size of a resource system, mobility of a resource unit, level of governance, users’ knowledge of the resource system), which are further composed of deeper-level variables.

49. Ostrom, E., J. Burger, C. B. Field, R. B. Norgaard and D. Policansky (1999). “**Revisiting the commons: Local lessons, global challenges.**” *Science*, **284**: 278 - 282.

In a seminal paper, Garrett Hardin argued in 1968 that users of a commons are caught in an inevitable process that leads to the destruction of the resources on which they depend. This article discusses new insights about such problems and the conditions most likely to favor sustainable uses of common-pool resources. Some of the most difficult challenges concern the management of large-scale resources that depend on international cooperation, such as fresh water in international basins or large marine ecosystems. Institutional diversity may be as important as biological diversity for our long-term survival.

50. Ostrom, E. and H. Nagendra (2006). “**Insights on linking forests, trees, and people from the air, on the ground, and in the laboratory.**” *Proceedings of the National Academy of Sciences* **103**(51): 19224-19231.

Governing natural resources sustainably is a continuing struggle. Major debates occur over what types of policy “interventions” best protect forests, with choices of property and land tenure systems being central issues. Authors provide an overview of findings from a long-term interdisciplinary, multiscale, international research program that analyzes the institutional factors affecting forests managed under a variety of tenure arrangements. This program analyzes satellite images, conducts social-ecological measurements on the ground, and tests the impact of structural variables on human decisions in experimental laboratories. Satellite images track the landscape dimensions of forest-cover change within different management regimes over time. On-the-ground social-ecological studies examine relationships between forest conditions and types of institutions. Behavioral studies under controlled laboratory conditions enhance our understanding of explicit changes in structure that affect relevant human decisions. Evidence from all three research methods challenges the presumption that a single governance arrangement will control overharvesting in all settings. When users are genuinely engaged in decisions regarding rules affecting their use, the likelihood of them following the rules and monitoring others is much greater than when an authority simply imposes rules. These results support a frontier of research on the most effective institutional and tenure arrangements for protecting forests. They move the debate beyond the boundaries of protected areas into larger landscapes where government, community, and comanaged protected areas are embedded and help us understand when and why deforestation and regrowth occur in specific regions within these larger landscapes.

51. Pagdee, A., Y.-S. Kim and P. J. Daugherty. (2006). “**What makes community forest management successful: A meta-study from community forests throughout the world.**” *Society & Natural Resources*, **19**(1): 33-52.

This is a review article to find an answer to what makes community forest management successful worldwide. Thirty-one articles on community forestry, encompassing 69 case studies worldwide, were reviewed for systematic data synthesis and hypothesis testing. The meta-study identifies 43 independent variables ranging from internal attributes of the community and resources to external factors. Variables with significant influence on the success of community forestry are tenure security, clear ownership, congruence between biophysical and socioeconomic boundaries of the resources, effective enforcement of rules and regulations, monitoring, sanctioning, strong leadership with capable local organization, expectation of benefits, common interests among community members, and local authority. Certain general structures and principles are required for the robust self-governance that enables CFM to continue to conduct successful community activities. The three factors discussed most frequently as necessary for the success of CFM were well-defined property rights, effective institutional arrangements, and community interests and incentives; these all had a significant association with success. Other factors identified as important to the success of CFM, such as financial and human resource support, physical features, community features, level of participation, and technology and market influence, were discussed less frequently in the selected case studies, perhaps because they are more case specific. In conclusion, CFM offers an alternative approach for achieving forest sustainability by integrating the knowledge and professional skills of foresters with the knowledge and resources of the local community. The decision to adopt CFM depends on community acceptance of, and commitment to, this type of resource management. Regardless of where it is taking place, the future of CFM and its likelihood of success involve the creation of a complex relationship between the community and the ecosystem that provides appropriate feedback to the community and creates the ability to respond to ecological, social, and economic changes over time.

52. Pandey, D. N. (1991). “**Joint forest management in Rajasthan.**” *Yojana* **35**(18): 23-29.

It is noted that JFM in tropical dry forest regions involving the direct seeding as a low cost regeneration method gave better results often surpassing planted seedlings within one to two years. Low cost regeneration can actually liberate communities and foresters from depending on large projects and associated bureaucratic hurdles. Topics discussed in this policy paper include joint forest

management, direct seeding, tropical dry forests, resprouting, and regeneration in Rajasthan, India.

53. Pandey, D. N. (1993). “**Wildlife, national parks and people.**” *Indian Forester*, **119**(7): 521-529.

It is argued that effective participation by the people is the key to wildlife conservation in India, both in natural ecosystems, and in wildlife reserves/national parks where provision of a sustainable livelihood security is necessary for indigenous people and people living in local communities.

54. Pandey, D. N. (1996). ***Beyond Vanishing Woods: Participatory Survival Options for Wildlife, Forests and People***, CSD & Himanshu Publishers, New Delhi.

This is a book on the field experiences of JFM in Rajasthan. On the one hand, the sustainability of essential ecological processes and life support systems is threatened in the wilderness, and on the other, at stake is the security of a just and dignified livelihood of the people living in and around forests and protected areas. Forest conservation and livelihoods security are, therefore, the two fundamental objectives for the JFM in India. People oriented strategies for natural resource management can help us overcome the crises of ecological disaster and threatened livelihoods in India.

55. Pandey, D. N. (2001). ***Ethnoforestry Practices for Biodiversity Conservation and Management in Mewar Region of Rajasthan***. PhD Thesis, FRI Deemed University, Dehra Dun.

Ethnoforestry is the study of continued practice of creation, conservation, management and use of forest and tree resources, through customary ways, by local communities. This study attempted to document the ethnoforestry practices for conservation and management of biodiversity in Mewar region of Rajasthan. The research attempted to gain understanding of the significance of local forest management systems to effectively address the threats that biodiversity confronts in India. It also explored and compared the general principles of scientific forestry and its history with ethnoforestry practices in order to provide insights for sustainable forest management. It also explored ways to integrate local and formal forestry. Study clearly brings out that in the indigenous systems of forests management and biodiversity conservation the leading factor responsible for long-term sustainability is the presence of locally-designed systems for monitoring, rulemaking and enforcement.

56. Pandey, D. N. (2002). “**Global climate change and carbon management in multifunctional forests.**” *Current Science*, **83**(5): 593-602.

Fossil-fuel burning and deforestation have emerged as principal anthropogenic sources of rising atmospheric CO₂ and consequential global warming. Variability in temperature, precipitation, snow cover, sea level and extreme weather events provide collateral evidence of global climate change. This article reviews recent advances on causes and consequences of global climate change and its impact on nature and society. It also examine options for climate change mitigation. Impact of climate change on ecology, economy and society -the three pillars of sustainability - is increasing. Emission reduction, although most useful, is also politically sensitive for economic reasons. Proposals of the geoengineering for iron fertilization of oceans or manipulation of solar flux using stratospheric scatters are yet not feasible for scientific and environmental reasons. Forests as carbon sinks, therefore, are required to play a multifunctional role that includes, but is not limited to, biodiversity conservation and maintenance of ecosystem functions; yield of goods and services to the society; enhancing the carbon storage in trees, woody vegetation and soils; and providing social and economic well-being of people. This paper explores strategies in that direction and concludes that the management of multifunctional forests over landscape continuum, employing tools of conservation biology and restoration ecology, shall be the vital option for climate change mitigation in future.

57. Pandey, D. N. (2002). “**Sustainability science for tropical forests.**” *Conservation Ecology* **6**(1): r13. [online] <http://www.consecol.org/vol6/iss1/resp13>.

Paper is about the sustainability of tropical forests. Tropical forests are vital for social, economic, and ecological reasons. And there is a need to explore the core questions of sustainability science in

the context of local livelihoods and tropical forests in order to design robust policy and practice for adaptive tropical forest management. The core issues of sustainability science relevant to livelihoods improvement and adaptive tropical forest management include: (i) Incorporation of nature-society interactions into models of Earth systems, human development, and sustainability, (ii) Insights about the changing nature-society interactions caused by long-term trends in population and consumption, (iii) Contextual factors related to the vulnerability or resilience of the nature-society system, (iv) Limits on resource use, (v) Ethics, incentives, and knowledge that promote sustainable nature-society interactions, (vi) Comprehension of crucial knowledge, (vii) Bringing researchers, planners, policy analysts, and practitioners together to learn, decide, and implement adaptive management. There is an urgent need to integrate the relatively independent activities of research, planning, monitoring, assessment, and decision support into systems for societal learning and adaptive management of tropical forests. Society has been greatly lacking in this regard.

58. Pandey, D. N. (2003). “**Cultural resources for conservation science.**” *Conservation Biology*, **17**(2): 633-635.

Conservation science of tomorrow will be a bouquet of tools drawn across disciplines from the natural and social sciences, and local and formal knowledge systems. The well-being of human society is closely related to that of natural ecosystems. Ecological, economic, social, spiritual, ethical, and aesthetic perspectives all have a role to play in bringing conservation science into the hearts and minds of people. A careful use of cultural resources, such as local knowledge and environmental ethics, provides options to design innovative policies and programmes for nature conservation. Every human being needs three indispensable virtues—altruism, compassion, and self-restraint—to interact with the diversity of species and ecosystems. We also need to abandon the notion that money and science can solve all our conservation problems. Local knowledge and environmental ethics may be equally useful resources for conservation science to bank on.

59. Pandey, D. N. (2004). “**Ethnforestry and sustainability science for JFM.**” In, V. K. Bahuguna, K. Mitra, D. Capistrano and S. Saigal (eds.), *Root to Canopy: Regenerating Forests through Community-State Partnerships*. New Delhi, Winrock International India/Commonwealth Forestry Association-India Chapter: p. 195-209.

This is a descriptive paper based on the experience and research as a forest manager in Rajasthan. It is suggested that JFM requires tools drawn from the natural and social sciences. Local knowledge practices, innovations and skills can contribute to ecological economic and social well being through a community-based management regime of natural resource management in India. It is also necessary to abandon the belief that provisioning of financial resources and scientific knowledge can solve all the problems that JFM confronts. Local knowledge systems and environmental ethics must be considered as useful resources for the sustainability of joint forest management in India. Topics discussed include literature review, case study, ethnforestry, indigenous knowledge, traditional knowledge, restoration, conservation, joint forest management, and sustainability science.

60. Pandey, D. N. (2007). *What Determines the Success of JFM in Rajasthan? Theory, Observation and Experience*. Forestry Training Institute, Jaipur, Rajasthan, India.

This review paper presents the determinants of sustainability of JFM in India. It draws on personal experience of the author, experience of other practitioners (as available in literature), and research (as available in published scientific papers). The paper also draws on personal observations of CFM across Asia, Africa, Europe, North America, South America and Australia. Determinants of success of JFM: 1. *Institutions*: Leadership, sanctioning; layered institutions; local rule making; and local enforcement. Locally evolved institutional arrangements are major factors that contribute to JFMC functioning; institutional arrangement refers to norms, rules and regulations which are locally made and implemented. 2. *Interactions*: Who talks with whom, and what is the impact of interactions? How interactions are followed and acted upon? How promises are kept or broken?

Social capital, social networks, peer-to-peer learning. 3. *Monitoring and adaptation*: To generate data, information and knowledge, and to ensure the use of knowledge for solid action. 4. *Local rule making and local enforcement*: as opposed to exogenous rule making and external enforcement. 5. *Livelihoods improvement*: Four ways—employment, village development, sharing of goods, and sharing of service payments—their relative merits. Payments for Environmental Services: ecotourism, watershed protection, carbon sequestration, biodiversity conservation. 6. *Generating and linking knowledge to action*: so that the creative ideas result in solid innovations, availability of resources to link knowledge to action, four key factors: habit of evidence-based decision making, co-production and co-synthesis of problem-based knowledge, integration of knowledge systems, easy access to knowledge.

61. Pandey, D. N. (2007). “**Joint forest management in Rajasthan: Case studies of two villages in Udaipur District.**” *Financing Agriculture* **39**(1): 12-21.

This paper is an extract of author’s earlier work reported during 1991-1996. Rural development through participatory forestry is a dynamic process for promoting the economic, social and environmental growth, increased agricultural and silvicultural productivity, and enhancing the prospects of basic needs and services in rural areas. Forestry promises a vast potential to achieve the indigenous rural development through the integrated management of natural resources. The achievement of the aims of rural development to a large extent depends upon the availability and use patterns of natural resources including land, forests, soils, water and trees etc. Planners in India have now realised the importance of forestry and integrated rural development planning to enhance the availability of goods and services to the rural people. Topics discussed include case studies on joint forest management, sustainability, forest restoration, and village development about Rajasthan, India.

62. Pandey, D. N. (2010). “**Critical necessity of local monitoring and enforcement for sustainable governance of forests.**” *Indian Forester*, **136**(9): 1155-1163.

A large number of variables may potentially determine the success or failure of sustainable governance of forests, yet the success in finding the necessary condition has remained elusive. Recently, the Nobel Prize for 2009 in Economic Sciences has been awarded to Elinor Ostrom who made major contributions to our understanding of the governance of forests and common pool resources. Ostrom has spent considerable amount of time and efforts with the International Forestry Resources and Institutions programme that produced some of the most useful research relevant to practitioners of natural resource management. This paper reviews the recent research that clearly demonstrates that even when a number of other factors are taken into account, higher levels of local monitoring and enforcement of locally-made rules can result in improved regeneration and lower the possibility of forest degradation across a variety of ecological, economic and social contexts. This understanding has immediate practical utility for joint forest management in India.

63. Pandey, D. N. and J. Y. Campbell (1996). “**How far can we stretch the forests? moving from joint forest protection to joint forest management.**” Annual Workshop of the International Association for the Study of Common Property, California, Berkeley, USA.

This paper is a review as well as collection of managerial experiences in the field. It is argued that Innovations are discouraged in the centralized systems in which JFM operates. Silvicultural decisions on the treatment of particular forest patches and the harvesting are still centralized. Working plans are prepared by a special Divisional Forest Officer, distinct from the territorial officer who must implement them. These plans must then be approved at regional level. Exceptions and deviations of these plans must be approved at a state level. In many states micro-plans must also be approved at a senior officer level. This kind of highly centralized decision making structure militates against the site specific and adaptive management in which prescriptions may have to be modified annually and in order to fine tune the more complex interactions between sets of management activities.

64. Poffenberger, M., N. H. Ravindranath, D. N. Pandey, I. Murthy, R. Bist and D. Jain (2001).

Carbon Credit Financing for Joint Forest Management in India: An Exploratory Study from Harda Division, Madhya Pradesh. IIFM, Bhopal/CFI, Santa Barbara, California: 74 pp.

This is a research report suggesting the feasibility that JFM may get additional resources from environmental service financing initiative in India such as carbon-offset credit. Degraded forests, where community forest management has yet to be established, offer the greatest potential for future carbon sequestration and seem the best positioned to receive financing through carbon offset credit programs. Topics discussed include carbon sequestration, joint forest management, carbon finance, payments for environmental services, restoration, and community forests in Harda, Madhya Pradesh, India.

65. Poteete, A. R. and E. Ostrom (2008). “**Fifteen years of empirical research on collective action in natural resource management: Struggling to build Large-N databases based on qualitative research.**” *World Development*, **36**(1): 176-195.

Many debates exist among social scientists that relate to the “best” way of collecting data about important theoretical questions. As scholars, who conduct individual case studies as well as participate in large-N studies combining qualitative and quantitative data, authors recognize the value of each research strategy and trade-offs in choosing between them. A combination of qualitative and quantitative methods to build on the strengths of each is required. A meta-analysis of the scholarly literature indexed during 1990-2004 on collective action related to natural resource governance yielded strong evidence that small-N studies are still the dominant empirical method. The continued reliance on research designs with limited comparative scope reflects practical challenges that limit the quantity and geographic breadth of data that any one researcher can collect using field-based research. Authors discuss the relative merits and shortcomings of two strategies for overcoming those challenges: Meta-databases constructed from existing qualitative studies and large-N field-based studies. Resource constraints, career incentives, and, ironically, collective action problems among researchers currently limit adoption of these strategies.

66. Robbins, P., A. Chhangani, J. Rice, E. Trigosa and S. Mohnot (2007). “**Enforcement authority and vegetation change at Kumbhalgarh wildlife sanctuary, Rajasthan, India.**” *Environmental Management* **40**(3): 365-378.

Land cover change in protected areas is often associated with human use, especially illicit extraction, but the direction and spatial distribution of such effects and their drivers are poorly understood. Authors analyze and explain the spatial distribution of vegetation change at the Kumbhalgarh Wildlife Sanctuary in the Aravalli range of Rajasthan, India using remotely sensed data and observation of conservation institutions. Two satellite images are examined in time series over the 13 years following the founding of the sanctuary through a cross-tabulation technique of dominant classes of vegetation density. The resulting change trajectories are compared for their relative distance to high-traffic forest entrance points for local users. The results show 28% of the study area undergoing change, though in multiple trajectories, with both increasing and decreasing density of vegetation in discrete patches. Areas of change are shown to be closer to entrance points than areas experiencing no change. The patchiness of change results from complex issues in local enforcement authority for middle and lower-level officials in Forest Department bureaucracy, leading to further questions about the efficacy and impact of use restrictions in Protected Areas.

67. Robbins, P., K. McSweeney, A. K. Chhangani and J. L. Rice (2009). “**Conservation as it is: Illicit resource use in a wildlife reserve in India.**” *Human Ecology* **37**(5): 559-575.

While wildlife conservation efforts have become increasingly aggressive around the world, illicit use of resources in conservation areas has not subsided, raising questions about the ecological character of noncompliance activities. This paper reviews the results of research conducted amongst

foresters and households living adjacent to a wildlife sanctuary in India in a period following a ban of human use activities. Using a formal survey supplemented by interviews and participant observation, the research sought to determine the intensity of illicit use, the demographics of resource users, and the attitudes of rulebreakers. The results suggest that noncompliance with conservation restrictions is nearly universal, that forest use is highly specialized, that available village resource assets do little to offset forest use, and that rule-breakers prefer current governance arrangements. These results paint a picture of deeply institutionalized forest use that suggests serious barriers to any simple enforcement solutions or governance reforms.

68. Sarker, D. (2009). “**Joint forest management: Critical issues.**” *Economic and Political Weekly* 44(5): 15-17.

The Joint Forest Management circular that took the National Forest Policy (1988) as its basis for people’s involvement in the development and protection of forests, issued more than 18 years ago, has failed in its attempt to utilise forest wealth to improve local livelihoods. The structure of the JFM is skewed towards the forest department and needs to be balanced with equal opportunities and rights to the participating communities.

69. Singh, V. S., D. N. Pandey and P. Chaudhry (2010). “**Urban Forests and Open Green Spaces: Lessons for Jaipur, Rajasthan, India.**” *RSPCB Occasional Paper No. 1/2010*. Jaipur, Rajasthan, India, Rajasthan State Pollution Control Board: pp. 23.

In an era of global climate change and rapid urbanization, innovations on governance of urban systems are critically required as 50% people are now living in less than 3% of the earth’s urbanized terrestrial surface. Without careful production of knowledge, and large investments to link that knowledge to action, cities will be overwhelmed with environmental challenges. Both policy and science now emphasize the critical necessity of green areas within urban social-ecological systems. Here, authors review the present status of urban forestry across the world, and draw lessons that can be applied for the governance of urban green spaces during the development of Jaipur as a world-class city in Rajasthan. There is a wide variation both in coverage as well as per capita availability of green spaces. There are, however, some discernible trends emerging from cities renowned for their urban green spaces: approximately 20 to 30% coverage of the total geographical area, and 15 to 25 m² urban green spaces per capita. World Health Organization suggests ensuring at least a minimum availability of 9 m² green open space per city dweller. Finally, authors provide strategies and lessons for connecting science to decision-making aimed at creating multifunctional landscapes to enhance urban resilience and human well-being.

70. Somanathan, E., R. Prabhakar and B. S. Mehta (2009). “**Decentralization for cost-effective conservation.**” *Proceedings of the National Academy of Sciences*, 106(11): 4143-4147.

Since 1930, areas of state-managed forest in the central Himalayas of India have increasingly been devolved to management by local communities. This article studies the long-run effects of the devolution on the cost of forest management and on forest conservation. Village council-management costs an order of magnitude less per unit area and does no worse, and possibly better, at conservation than state management. Geographic proximity and historical and ecological information are used to separate the effects of management from those of possible confounding factors.

71. Tole, L. (2010). “**Reforms from the Ground Up: A Review of Community-Based Forest Management in Tropical Developing Countries.**” *Environmental Management* 45(6): 1312-1331.

After an initial burst of enthusiasm in the 1990s, community-based forest management (CBFM) is increasingly being viewed with a critical eye. Evidence suggests that many programs have failed to promote their stated objectives of sustainability, efficiency, equity, democratic participation and poverty reduction. A large volume of academic literature now exists on CBFM, examining both the success and failure of such initiatives in a wide variety of countries. Through analysis of key themes,

concepts and issues in CBFM, this article provides a review of CBFM initiatives in tropical developing countries for policymakers, practitioners and planners wishing to gain an understanding of this wide-ranging, interdisciplinary academic literature. The article identifies key institutions and incentives that appear to significantly affect the success or failure of CBFM initiatives. In particular, it reports that consideration of institutional and socioeconomic factors along with personal characteristics of key stakeholders such as beliefs, attitudes, financial resources and skills are important determinants of CBFM outcomes. However, local incentive structures also appear to be important. There is increasing recognition in the literature of the need to consider the conditions under which local politicians entrusted with carrying out CBFM initiatives will deem it worthwhile to invest their scarce time and resources on environmental governance.

72. Tucker, C. M. (2010). “**Learning on governance in forest ecosystems: Lessons from recent research.**” *International Journal of the Commons* 4(2): 687–706.

Research on forest governance has intensified in recent decades with evidence that efforts to mitigate deforestation and encourage sustainable management have had mixed results. This article considers the progress that has been made in understanding the range of variation in forest governance and management experiences. It synthesizes findings of recent interdisciplinary research efforts, which indicate that sustainable management of forest resources is associated with secure rights, institutions that fit the local context, and monitoring and enforcement. At the same time, the variability in local contexts and interactions of social, political, economic and ecological processes across levels and scales of analysis create uncertainties for the design and maintenance of sustainable forest governance. By identifying areas of progress, lessons learned, and gaps in knowledge, the discussion suggests priorities for further research.

73. Umemiya, C., E. Rametsteiner and F. Kraxner (2010) “**Quantifying the impacts of the quality of governance on deforestation.**” *Environmental Science & Policy* DOI: 10.1016/j.envsci.2010.07.002

The quality of governance is known to have effects on deforestation, together with other social and economic factors. However, assessing the impact of governance quality is a challenging task due to the complex and diverse mechanisms of deforestation as well as limited data availability. In this paper, interrelations between governance quality and deforestation rates are analysed on a global scale, using national data on governance quality and deforestation. Results indicate an increase in governance quality tends to be associated with a decrease in deforestation rates (i.e., a lower level of deforestation). The paper then discusses the limitations of the quantitative assessment, including data issues.

74. Van Laerhoven, F. (2010). “**Governing community forests and the challenge of solving two-level collective action dilemmas: A large-N perspective.**” *Global Environmental Change* 20(3): 539-546.

The effectiveness of forest governance practices has consequences that range from the local to the global level. This study uses a large-N, cross-national dataset rather than case studies alone. What constitutes an effective local forest governance regime? Chiefly monitoring, and to a lesser extent, maintenance, is correlated with improving forest conditions. When are effective governance regimes likely to emerge? Social capital, organization, leadership and autonomy contribute to the development of institutions for collective action. How does competition between forest users affect governance? Two-level collective action dilemmas hinder the emergence of effective governance regimes.

75. Wade, R. (1988). *Village Republics: Economic Conditions for Collective Action in South India*. Cambridge, Cambridge University Press.

Why do some people get together to manage their common assets? Why do other groups of people leave those assets to be over-exploited by each member of the group? The answers could

be crucial to the proper maintenance and use of ‘common property resources’, from grazing land through fish stocks to irrigation water. Robert Wade, drawing on research in areas of Andhra Pradesh where rain is scarce and unreliable, argues that some villagers develop and finance joint institutions for cooperative management of common property resources in grazing and irrigation - but others do not. The main reason lies in the risk of crop loss. Villages located towards the tail-end of irrigation systems, and with soils fertile enough to support a high density of livestock, show a larger amount of corporate organization than villages elsewhere. Placing his work in the wider context of both the developing world today and the open-field system of medieval Europe, the author argues that peasants can under certain conditions organize collectively. Privatization or state regulation are not the only ways of preventing degradation of common property resources in peasant societies.

76. Walker, K. L. (2009). “**Protected-area monitoring dilemmas: a new tool to assess success.**” *Conservation Biology* **23**(5): 1294-1303.

This research used a law-enforcement and monitoring game-theory model from the political science literature to identify three key variables useful in predicting the success of a protected area: costs of monitoring for rule breakers, benefits of catching a rule breaker, and probability of catching a rule breaker if monitoring. Although assigning exact values for each of these variables was difficult, the variables had a strong predictive capacity even when coded as coarse ordinal values. A model in which such values were used correctly predicted the outcome of 88 of 116 protected areas sampled from the peer-reviewed literature. The model identified a critical zone of common mismatch between protected-area circumstances and management policies. In situations where the costs of monitoring were greater than the product of the probability of catching a rule breaker and the benefit of doing so, conservation was unlikely to succeed. Control of illegal use of protected resources was reported in only 8% of such cases, regardless of strategies to motivate potential users to cooperate with conservation.

77. Wollenberg, E., L. Merino, A. Agrawal and E. Ostrom (2007). “**Fourteen years of monitoring community-managed forests: learning from IFRI’s experience.**” *International Forestry Review* **9**(2): 670-684.

The purpose of this paper is to review the experiences of the International Forestry Resources and Institutions (IFRI) to inform other efforts to systematically monitor community-managed forests or conduct network-based investigation of locally managed natural resources. The review is based on visits and reviews of IFRI activities in Uganda, Mexico and Thailand, surveys and interviews with IFRI members, and a global internet survey and interviews with people active in international forest management. IFRI members also actively participated in the review. The paper describes IFRI, its achievements and the challenges it has faced in its development. Although community managed forests constitute a significant proportion of the worlds’ forests, there is little information about their condition or how they are managed. The IFRI network is a research programme established in 1992 to collect interdisciplinary information about forest sustainability and governance. IFRI is unique in terms of the large number of small-scale sites monitored (more than 350 communities and 9000 forest plots) for more than a decade, under the guidance of strong central leadership, a well defined research framework, relative autonomy of network members, and a strong inward focus. These features have enabled IFRI to have particular impacts on new knowledge, policy and local communities, and capacity building. Lessons about how to further strengthen, extend and sustain these impacts include developing more robust agreement about measures of forest sustainability, building network members’ capacities to conduct comparative analysis, ensuring the database meets the needs of multiple users and expanding the membership and outreach of the network.

ANNEXURE - 1

List of Variables

Critical enabling conditions for sustainability on the commons as identifies by Agrawal (2001)

1) Resource system characteristics

- i) Small size
- ii) Well-defined boundaries
- iii) Low levels of mobility
- iv) Possibilities of storage of benefits from the resource
- v) Predictability

2) Group characteristics

- i) Small size
- ii) Clearly defined boundaries
- iii) Shared norms
- iv) Past successful experiences—social capital
- v) Appropriate leadership—young, familiar with changing external environments, connected to local traditional elite
- vi) Interdependence among group members
- vii) Heterogeneity of endowments, homogeneity of identities and interests
- viii) Low levels of poverty

(1 and 2) Relationship between resource system characteristics and group characteristics

- i) Overlap between user-group residential location and resource location
- ii) High levels of dependence by group members on resource system
- iii) Fairness in allocation of benefits from common resources
- iv) Low levels of user demand

v) Gradual change in levels of demand

3) Institutional arrangements

- i) Rules are simple and easy to understand
- ii) Locally devised access and management rules
- iii) Ease in enforcement of rules
- iv) Graduated sanctions
- v) Availability of low-cost adjudication
- vi) Accountability of monitors and other officials to users

(1 and 3) Relationship between resource system and institutional arrangements

- i) Match restrictions on harvests to regeneration of resources

4) External environment

- i) Technology
 - a) Low-cost exclusion technology
 - b) Time for adaptation to new technologies related to the commons
- ii) Low levels of articulation with external markets
- iii) Gradual change in articulation with external markets
- iv) State
 - a) Central governments should not undermine local authority
 - b) Supportive external sanctioning institutions
 - c) Appropriate levels of external aid to compensate local users for conservation activities
 - d) Nested levels of appropriation, provision, enforcement, governance

Measures of success as summarized by Pagdee et al. (2006)

S1. Ecological sustainability includes:

A. Improve forest conditions (e.g., increase of forest area, species diversity, forest productivity, and number of valuable species).

B. Address environmental degradation (e.g., reforestation, soil erosion protection, and watershed management).

S2. Equity refers to:

- A. Enhance equitable sharing of the management function (right to manage), entitlement (right to access and control), and responsibility for a given territory or set of natural resources.
- B. Improve equitable benefit distribution among community members.
- C. Increase investment in the future productivity of the forests.

S3. Efficiency includes:

- A. Meet a range of local needs, improve local living standard, and alleviate poverty.
- B. Reduce conflicts between local communities and authorities.
- C. Control corruption.
- D. Resolve mismanagement (e.g., imbalance of administrative power, and imbalance between ecological and socioeconomic dimension).
- E. Reduce individual misuse of the forest (e.g., timber smuggling).

Factors identified as important to the success or failure of community forest management, summarized from articles reviewed in the meta-analysis by Pagdee et al. (2006)

F1. Property rights regimes:

- A. Security of tenure to a resource (e.g., long-term benefits, legal land holding and title).
- B. Clear ownership to use and manage a resource (e.g., shared and exclusive rights in decision-making).
- C. Clearly defined boundaries of the community resources—physical boundaries of the forest.
- D. Designated areas for specific use of the forest.
- E. Congruence between biophysical of the community and resources and social boundaries (e.g., social norms and rules restricting time, place, technology, and use of the resources).
- F. Rules to regulate the use of forest products both in formal and informal forms.

F2. Institutions:

- A. Effective enforcement of rules and regulations to control rule breakers, and brings those rule breakers to justice.

- B. Monitoring methods to assess if institutional framework remains applicable to the community.
- C. Sanctions and penalties.
- D. Skillful and experience administrative members with self-governing resource management.
- E. Strong leadership and effective local organizations with available financial and human resources.

F3. Incentives and interests:

- A. Value. A resource obtains value at some degree that is worth it for the community to establish local groups responsible for resource management.
- B. Cost of CFM investment and institutional change.
- C. Expectation that benefits will accrue to villagers when participating in management programs.
- D. Forest dependency. The forest is considered a source of community basic needs (e.g., food, fuelwood, and medicines, as a place to practice community traditions).
- E. Sharing of common interests that will lead a group of people to create community management.

F4. Financial and human resource support from both local and outside agencies to run management programs:

- A. Willingness of authorities and staff to implement CFM.
- B. Financial and human resource support from NGO, government agencies, international institutions, and individuals.
- C. Technical assistance from forestry officials to the community.

F5. Physical features of the forests:

- A. Forest size in area. Large vs. small sized forest.
- B. Location. Accessibility of the location, easy access to outside communities.
- C. Diversity (e.g., forest types, ecological complexity). High vs. low diversity.
- D. A current level of resource degradation. Severe and not severe. The level of degradation could cause lack of motivation to participate in CFM programs.
- E. The trends of forest destruction are increasing, stable, or decreasing.
- F. Predictability of resource flows. (1) Relatively predictable and (2) relatively unpredictable.

F6. Community features include:

- A. Community size. Large vs. small-sized community.
- B. Location. Close proximity to the forest.

- C. Increasing population growth.
- D. Increasing level of migration.
- E. Presence of conflicts between local people and outsiders.
- F. Social-cultural diversity and heterogeneity.
- G. Economic conditions of community members.
- H. Community experience in cooperative works.
- I. Traditional practices. Villagers maintain traditional techniques to use and harvest forest products.

F7. Level of participation:

- A. When the majority of community members participate in a management program, the program seems to become more successful.

F8. Degree of decentralization:

- A. Local recognition.
 - (1) Legal recognition of local group / authority in forest management.
 - (2) Informal recognition of local group: no legal status of the local group, but officials work together with the community.
 - (3) Acceptance of local group: no legal status, no cooperative work between officials and community, but local groups are allowed to work by themselves.
 - (4) No local recognition.
- B. Clear procedures for exercising local controls.
- C. Relocation of administrative function to local groups (local responsibility).
- D. Relocation of budget resources of administration (local authority).

F9. Technology and market influence:

- A. Technological changes.
- B. Higher market demands for forest products and increasing economic value of some forest products.
- C. Introduction of infrastructures.
- D. Instability and fluctuation of market conditions.