Drivers of regrowth in South Asia's human impacted forests

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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.

Keywords: Forest transition, institutions, protected areas, reforestation, South Asia.

Introduction

As the human footprint on the earth's natural resources continues to expand, the earth's environment and ecology have experienced increasing deterioration over the past several centuries. Declining forest cover has been one of the biggest contributors to global environmental change, impacting a range of ecological and environmental services including global temperatures, health, biodiversity, air quality, soil fertility and water flows. Reduction in the quantity and quality of forests has also had a major impact on the quality of life and livelihoods for the many millions of forest-dependent inhabitants around the world. These impacts are particularly acute in the tropics, where forests coexist with high population densities[1]. This article discusses findings from a set of studies conducted over the past five years that is aimed at developing a better understanding of the relationship between institutions and forest change in such complex, human dominated yet biodiverse landscapes.

While awareness of the problem of deforestation is growing, considerable debates rage on the best way to manage forest change. A basic problem has been the availability of accurate datasets that track the extent, location, direction and spatial pattern of forest change in different parts of the world. Surprisingly, such information remains elusive even in this electronic age, posing a major barrier to our understanding of the drivers of forest change[2].

The most comprehensive, large-scale and long-term datasets with information on forest change at a national scale are provided by the United Nations Food and Agricultural Organization (FAO): for 1980, 1990, 2000 and 2005. These data have been used by many researchers to search for factors driving forest change, such as population, at country scales (e.g. ref. 3). Yet, these data are provided at different scales, based on information provided by over 200 countries, and have been strongly criticized for providing an inaccurate picture biased by changes in methodology, and in frequently changing baseline definitions of forest[4,5].

Recently, this data situation has improved for the tropics, with corrected estimates of FAO statistics[5], as well as more reliable and robust assessments of the rates of tropical deforestation from large-scale satellite image studies[6,7]. While these provide somewhat different estimates of global forest change and show that deforestation continues to be the dominant trajectory of land cover change in the tropics, they also point to something interesting – a rising trend in reforestation, with an increase in secondary forests in multiple parts of the tropics, including countries as diverse as Bhutan, Puerto Rica and Gambia[5].

The information provided by these large-scale datasets is further corroborated by a growing body of recent literature, which suggests an increase in forest regrowth across the tropics[8–10]. Large scale forest regrowth has been demonstrated across countries as varied as Brazil, China, Costa Rica, India, Mexico, Nepal, Puerto Rico, Tanzania and Vietnam. This reforestation is often patchy, with tropical forest landscapes typically consisting of a multiple-use mosaic ranging from remnant forest patches to disturbed and regenerating areas[8]. Nevertheless, the areas of reforestation provide important environmental services that range from carbon sequestration to soil conservation and the stabilization of hydrological cycles, biodiversity conservation and the maintenance of ecological services[7,9].

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Forest transition theory

What drives this increase in forest cover? Two dominant processes, or sets of processes, sometimes occurring in parallel, have been put forward as explanations. The first, macroeconomic explanation follows the lines of the Environmental Kuznets theory, and applies mainly to forest transitions in economically developed countries. While the documentation of forest regrowth in the tropics is a relatively recent phenomenon, forest transitions have been previously noted in many economically developed countries in the temperate world including Scotland, France and the USA. The majority of these transitions, occurring towards the last half of the 20th century, and in contrast to the tropics, have been relatively well documented and researched. As these nations became more industrialized and urbanized, there was an increasing demand for labour in urban centres. The corresponding scarcity of labour in the rural areas led to the abandonment of agricultural farms on a large scale, resulting in spontaneous reforestation[9]. This 'economic development path' to forest transition has been observed in northern Europe and north America after the first World War, and in more recently, in parts of Asia and eastern/southern Europe[3,9].

A second explanation is based on microeconomic explanations of forest scarcity. When forests are abundant, there is little or no incentive to limit forest clearing. Once forests begin to be cleared extensively, wood becomes a scarce but important commodity, prompting large-scale planting efforts by governments and local communities[9]. Evidence for this comes from a diversity of countries including India and China[2]. Yet, it is abundantly clear that there are several countries across the world which now experience fairly severe scarcities in forest products, but are unable to reverse the trend of deforestation due to factors that include the lack of supportive institutions, corruption by local elite, and the collapse of civil authority[2,9].

Developing a more comprehensive, area-specific and robust understanding of factors that can drive reforestation in multiple contexts is critical if we are to hope to encourage forest regrowth and arrest or reverse deforestation. These above described pathways, through important, do not by any means explain all the trends in forest cover observed. While playing an unquestionably significant role in driving forest regrowth across the world, the economic development path to forest transition is closely linked with global and national policies and trends towards modernization and economic development. Although some countries have demonstrated this trend, it is by no means universal and not of real assistance to conservation agencies, government officials and scientists interested in identifying policy interventions that can be of direct assistance. Nor can we afford to hope that the second path, an awareness of forest scarcity, will in itself be sufficient to reverse the direction of forest change – it has clearly been insufficient in several countries and locations[11].

Negative findings also prove difficult to reconcile with these theories. There are many countries where no link is seen between deforestation and per capita GDP, and no systematic linkage between higher per capita GDP levels and reforestation. Clearly, forest trends are not a function of economic growth or income alone. Neither do there appear to be direct links between country policies, governance and forest regrowth. It is difficult to explain trends in forest change by data collected at the country scale. A binary classification into forest transition and non-forest transition countries treats the issue at the wrong scale and completely ignores the fact that any country-indeed, even smaller regions, provinces or landscapes – will be composed of a mosaic of areas that are experiencing reforestation, along with other areas that are stable and areas where forests are disappearing at the same time[12,13]. It is difficult to understand what drives forest regrowth in specific areas by using aggregate information that grosses over these important variations in pattern, generated at gross scales. A better idea of the local factors driving forest regrowth in different contexts is clearly needed.

Forests and institutions

The data produced by the FAO Forest Resource Assessment of 2006 indicates that Asia is the first continent to experience forest transition since the mid 1900s. The slowing down and reversal of tropical deforestation has been noted in countries as varied as Bangladesh, Bhutan, China, India, South Korea and Vietnam[2,14]. Nepal, while experiencing net deforestation at the country scale, has also demonstrated significant forest regrowth in the middle hills since the 1980s[10,15]. Reforestation in many of these countries cannot be explained well by the forest scarcity and economic development pathways[2,10]. This implies the existence of other pathways and drivers, in addition to these better described ones.

Tenure systems, while essential to an understanding of forest cover change, have been largely ignored in discussions of forest transitions. Developing a more comprehensive understanding of the range of institutional, policy and tenure mechanisms that can help to promote reforestation is essential if we are to develop useful policy interventions. Considerable differences of opinion exist in this regard. While many conservation biologists insist that strict, nationally driven, protectionist conservation is essential for the protection of forest habitat, others argue that participatory community conservation with sustainable harvesting in 'working forests' can provide adequate forest protection and forest regrowth[16]. The data on this is mixed, with some cross-site studies indicating that gov-

ernment protected areas have succeeded in achieving their conservation objectives[17,18], while other studies indicate that management by local communities can be just as effective, if not even more so[19,20].

Part of the reason underlying these differences in opinion lies in the fact that forest change is a complex phenomenon, with multiple factors that interact at a range of scales to drive change in specific directions. Thus, isolating specific drivers responsible for forest change in one direction or another is a challenging task, methodologically as well as conceptually[11]. The task is further exacerbated by ideologically driven positions that have been taken by many scientists and practitioners coming from different positions. Finally, most studies are undertaken in specific locations, with few attempts to establish a broader understanding by undertaking comparative studies of change at multiple locations. Thus, we need to go beyond simplistic, limited and possibly flawed identifications of a single tenure regime or policy mechanism that can lead to reforestation in all social, cultural and economic settings, and instead to identify a range of factors that appear to be significant in driving forest change in one direction or another in different contexts. This will help us understand when and why deforestation and regrowth occur in specific regions within these larger landscapes.

This article discusses initial insights from a set of studies conducted over the past five years, aimed at developing a better understanding of the institutional drivers of forest regrowth in the Asian tropics. South Asia provides the context for this research. India and Nepal constitute some of the most densely populated of the world's forested countries. While both have experienced and continue to experience significant deforestation due to human pressure, they have also shown significant regrowth since the early 1990s (refs 2 and 10). Much of this can be traced to the strengthening of effective national, regional and local institutions[12]. While significant limitations still exist, it is illustrative to examine these studies in the context of work on collective-action theory as related to common-pool resources.

Forests, like many other natural resources, belong to the category of common-pool resources. They have two main characteristics: (i) it is very costly to exclude potential beneficiaries from accessing and harvesting from the resource and (ii) the amount of resource flows harvested by one user is subtracted from the quantity available to others[21]. Common-pool resources can be managed under any of a broad type of property-rights regimes, from government ownership to private ownership, community ownership and open-access situations. When the resource is open-access, in which there is no clear owner of the resource and unrestricted access is available to all, situations similar to the tragedy of the commons can arise. However, if access is restricted under conditions of government, private or community ownership, then the resource is capable of being well-protected, even regenerating over time[21].

Over the past several decades since Garret Hardin's 'Tragedy of the Commons' stimulated interest in this area, many researchers have invested substantial effort in evaluating the effectiveness of common property regimes and government institutions for the protection and sustainable use of natural resources[22]. The debate has been intensely polarized, with some scientists (including several conservation biologists) arguing that government-protected national parks are the only way to achieve successful conservation, and others (including many social scientists studying the adverse impacts of government institutions on local people) that community control is the way to go. Yet, it is becoming increasingly clear that no single institutional type can be a panacea for effective management under all situations[23]. Instead, one needs to look for rules-in-use that can help increase the probability that a given management regime – whether community, government, or co-managed – can be effective on the ground.

Until recently, many studies such as Garret Hardin's classic paper on the Tragedy of the Commons[24] predicted that users of a common-property resource such as forests were inevitably trapped into a situation where each user acted to maximize their own profits, leading to overuse and destruction of the resource. Yet, evidence is now mounting that, under appropriate circumstances, local communities can be very effective guardians of forest resources. Drawing on evidences from a number of local case studies as well as larger comparative cross-site analyses, this article reviews evidence on forest clearing and regrowth in Nepal and India to discuss under what conditions local and national institutions appear to be effective at promoting forest regrowth.

The local studies draw on methods developed as part of the International Forestry Resources and Institutions (IFRI) research programme. Coordinated by the University of Michigan and Indiana University, this programme is currently active in 13 countries across North America, Africa, Asia and Latin America[12]. This programme was designed to further the study of collective action in the management of forest resources by developing a long-term database of the factors affecting forests and the communities that use them. The IFRI programme has been active in both countries for more than a decade, and provides us with a large and valuable database that can be used to evaluate a range of factors that have been identified as impacting forest condition positively or negatively. The interdisciplinary methodology developed for this purpose documents biophysical measures of forest and environmental conditions, demographic and economic information, and data about institutions that impact forest resources. These features make IFRI an attractive resource for the assessment of hypothesized relationships among demographic, economic, institutional and biophysical variables driving forest change.

The range of biophysical and ecological context and ecology, and diversity of tenure arrangements over which this data has been collected, provide us with sufficient variation to be able to derive insight into the impact of a range of hypothesized drivers of forest change. This data, collected at the forest/community level (usually at the scale of forests that cover a few hectares to a few square kilometers in area), is supplemented with remote sensing analyses of forest cover change at the landscape level (of a few square kilometers in area)[10,12,13]. Such a two-pronged approach provides us with a way of going beyond the FAO reports which focus at the country scale, by integrating site-specific, in-depth understandings of the social, institutional and biophysical factors at individual locations, with broader comparative examinations of the factors that determine why forests disappear, stay stable and regrow in different parts of a landscape, and across different locations.

Associates of reforestation

Tenure

While examining a range of official tenure designations in forests located in Nepal, India and elsewhere around the world, we find a range of management regimes associated with effective forest management. In Nepal, some community forests, leasehold forests and co-managed buffer zone forests have shown significant forest regrowth, others have remained stable, or even deteriorated over time[10,12,13,18,25–32]. In India, some government protected areas and joint forest management institutions can lead to reforestation, whereas in other instances, the same tenure regimes are also associated with forest clearing[12,13,18,30,33,34]. These findings are backed up by larger, cross-country analyses that indicate that under effective conditions, both government and community protected areas are capable of providing effective forest protection, even encouraging regrowth in many cases[12,13,18].

Thus, it appears that formal ownership is less important than the actual rules and mechanisms used to manage forests on the ground. If forest regrowth can be shown to occur under a range of institutions, what are the other conditions that can facilitate or hinder successful forest management? Some other significant factors are discussed below.

Monitoring

Monitoring has emerged as one of the most significant factors that we have observed to be consistently associated with forest change. Without effective monitoring of withdrawals from the forest and sanctioning of infractions, it will always be difficult to prevent overharvesting of forest resources – as the temptations to extract resources for personal use are always large. If forest rules limiting access and harvest levels are either not known (as often is the case for communities living in and around protected areas), or are known but not considered legitimate by local resource users, then there will be a need for substantial investment in guns, fences and official guards to patrol boundaries to prevent 'illegal' harvesting.

Without these expensive inputs, government-owned, 'protected' forests may not be protected in practise. In these areas, the density of surrounding habitation is often high and nearby urban markets generate incentives for illegal wildlife and timber harvesting, as well as for grazing. Both local communities and external poachers attempt to harvest timber, graze cattle, and engage in other illegal activities within the park, leading to frequent conflicts with park authorities. Parks are often under-funded, understaffed and ill-equipped to adequately monitor the park, and enforce sanctioning measures on violators. Such monitoring and sanctioning measures, while they can be successful in the short term, also come at the expense of increased conflict with local communities. On the other hand, when efforts are made to involve local people in conservation activities such as forest monitoring and wildlife protection, substantial improvements have been noted in some areas[12,34].

In other contexts, usually found in community protected or co-managed areas, when the users themselves have a role in making local rules, they tend to participate more fully in monitoring and sanctioning of over-extraction. In co-managed buffer zone forests in Nepal, and Joint Forest Management forests India, through government officials make some visits to these areas for monitoring, the substantial proportion of the monitoring is contributed by the communities[27,29,33]. These co-management initiatives have the power of social approval behind them, and have succeeded in protecting forests even in the face of some very difficult and insecure situations such as during the Maoist insurgency in Nepal, signifying the resilience of these efforts.

Experimental findings corroborate this, indicating that when users are involved in decisions about rules affecting their use, the likelihood of their following the rules and monitoring others is much greater than when an external authority simply proscribes and imposes rules on them[12,13,21]. Social factors thus play a major role in the effectiveness of such monitoring[28]. Interestingly, it appears that even occasional monitoring, taking place every few months, is sufficient to bring about change in community monitored areas[10]. Even occasional monitoring can result in social sanctioning by the community in which people live. Given the closely linked communities within which many people live in these contexts, this threat can be quite effective in bringing about compliance from a wide cross section of users[21]. In contrast, government-controlled forests require frequent monitoring from armed forest

guards and even this is often not enough to guarantee compliance – or if it does, it comes at the expense of great resentment and conflict with local users[12,13].

Group size and collective action

Population has been frequently mentioned as a major driver of deforestation[35,36]. These discussions completely ignore institutions and the powerful capacities of people to organize themselves into collective groups to combat problems. We have found the relationship between the size of a group and the likelihood of successful collective action to be curvilinear[10,27]. When there are too few users relative to the size of the forest (less than five users per hectare of forest area), critical tasks such as forest planting, maintenance and monitoring cannot be carried out effectively, and forest density tends to decline. When there are too many users (more than 15 per hectare of forest area), when there is enough labour available for forest protection, planting and maintenance, cooperation and coordination between users tends to break down, making the task of forest protection even more difficult[10]. Thus, forest management appears to be most effective at intermediate group sizes between these extremes (also see ref. 37). Scale is an important factor that determines the relationship one observes between population and collective action.

Flexibility to adapt to local context

Institutions need to be allowed the flexibility to modify rules based on changing local environments and circumstances. Often this is not the case with national governments creating relatively inflexible one-size-fits-all rules and limiting the capacity of local communities to adapt to the change[18,27,28,30]. Often, neighbouring communities can face dissimilar pressures on their forests due to ecological, social and other differences, necessitating the adoption of different institutional rules for effective management. Yet, in the analyses of buffer zone user groups in the Nepal terai plains, leasehold user groups in the middle hills and Joint Forest Management programmes in India, we found that these groups were asked to function according to a rather restrictive set of management guidelines, in which they had limited flexibility to modify according to local circumstance[26–30].

These restrictions have understandably created a sense of lack of ownership in the communities and led to a greater reliance on external technical and management inputs provided by the state and international aid agencies, as well as to conflict between those communities that are part of these programmes and others who have been left out of such efforts. In contrast, the community forestry programme, while still functioning under limitations, has had a greater overall degree of flexibility to adapt and modify management practises to local needs. Although they have had initial problems, these community forestry groups have experimented and learned from their initial attempts, and are now putting better systems in place. Thus, clearly, community groups do better when given the flexibility to modify rules according to local social or ecological circumstances.

Discussion

Loss of forest cover represents a serious environmental challenge. Yet, significant reforestation has taken place in recent years in many parts of the world[2,9]. The dominant explanatory global frameworks of reforestation based on explanations of industrialization, improvements in per capita GDP, and increasing forest scarcity, fail to adequately explain reforestation in many developing nations including Nepal and India, where biodiverse forests coexist with densely settled areas. Such explanations focus on the drivers of forest change as if they always have the same momentum and direction in all settings. Further, these explanations are usually assessed at the national level, where data quality is often poor, degrees of freedom are limited, and confusion exists between correlation and causality. Rarely are these studies posed at more appropriate social–ecological system scales. They are less able to explain when and why forest regrowth takes place in certain areas within a country, region or landscape, while other nearby areas are simultaneously being cleared of their tree cover.

Such explanations also largely ignore institutions and the powerful capacities of people to organize themselves into collective groups to combat problems. The approach discussed here is aimed at achieving a better understanding of the institutional factors that impact the success or failure of forest management in different contexts. From the studies discussed, we find that the official designation of a forest tenure regime, whether as government, community, or co-managed, does not appear to have a consistent relationship with the direction of forest change. Although some government forests are successful, others fail – similarly, some communities are better able to manage their forests than others. What seems to be more critical is the legitimacy of ownership, degree of monitoring, density of forest users and the flexibility to adapt forest management rules as appropriate to local conditions.

Thus, in Nepal as well as in India, we find communities engaging in monitoring efforts to successfully manage forests when ownership is perceived as legitimate and fair. Traditional, strict public protection of parks can also work to protect forests. This comes with a high financial cost however, and appears unsustainable over the long-term as such measures result in increased conflicts with local communities. Although it may be a utopian dream to

assume that national governments will ever cede formal control of forests to local communities, increasingly, forest decentralization initiatives are leading to greater roles for local forest users[38]. Forest co-management, for instance as designed in many Nepali park buffer zones[26,27], provides one such approach where within one national park boundary, different groups of local users manage different patches of forest across the periphery, thus assisting in effective forest recovery. While great care must be taken in identifying critical stakeholders, and in ensuring that the poor and disadvantaged do not get left out of this process, such an approach can provide the greater flexibility required to adapt forest management to local socio–ecological settings, resulting in more effective, sustainable forest conservation over the long term.

Strong institutions can perhaps explain the discrepancy between the almost complete depletion of forests in many industrialized nations at the time of the forest transition (at less than 10% original forest cover remaining), and the higher levels of original forest cover (between 20 and 50%) observed in many industrializing countries where forest transitions are taking place[9]. Despite high levels of human pressure on forest resources, the maintenance of long standing tradition of forest protection, and of strong local institutions in these countries can have significantly assisted in forest recovery in these countries. This conservation of higher levels of primary forest cover in these countries has significant implications in terms of greater levels of maintained forest biodiversity[39].

It is important to develop better methods for studying such linked social–ecological systems across multiple scales, because the impact of relevant variables – such as population – can differ radically at different scales. The approach discussed here, using a combination of site-specific case studies and cross-site comparisons, is very useful to develop a better theoretical understanding of critical variables that impact the success or failure of forest governance as a common-property resource. Some of these, such as the impact of policy changes or local ecologies, may be specific to the context of particular case studies. Others, such as the role of monitoring on forest change, may derive from a more fundamental theoretical basis in human behaviour[21]. Certain groupings of driving forces may be local, others regional, and still others may be found across all contexts.

This article discusses evidence from long-term research programmes that use research methods that focus at different temporal and spatial scales, and that link empirical results obtained from multiple methods in field settings to look at the human drivers of forest cover change in a range of social–ecological contexts. These approaches are designed to move beyond the use of single, discipline-focused research methods which appear inappropriate to understanding such complex, multiscale processes as forest change. Approaches such as these, which integrate theories, methodologies and frameworks from the social and ecological sciences, appear better suited to derive understandings of how individuals in dynamic, complex, social–ecological settings react to institutional rules and affect forest conservation. They provide us with a more developed understanding of the factors that have the potential to direct the trajectory of forest change towards regrowth, or further deterioration.

Note

The opportunity to spend an independent period of five years working on the Society in Science: Branco Weiss fellowship from 2003 to 2008, gave me the opportunity to expand the horizons of my work in very fundamental ways. In addition to a fellowship and research grant that facilitated putting in place a relatively long-term, independent plan of work on forest cover, it gave me the opportunity of relative freedom from the routine academic treadmill, with plenty of opportunities to read, think, reflect and discuss work with other life scientists also facing the challenges of interdisciplinary research. This has led to fundamental alterations in the trajectory of my work, providing an opportunity to engage more deeply with the social sciences, giving me a chance to think about and engage with broader issues relating to the study of drivers of reforestation, devising strategies for putting together a broader body of work relating to land cover change in South Asia, and engaging with an urban ecology programme of work in India. All of these have now become major foci in my work and intellectual interests, and may well not have been possible to develop the same degree if it had not been for those much needed years of generous support.

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