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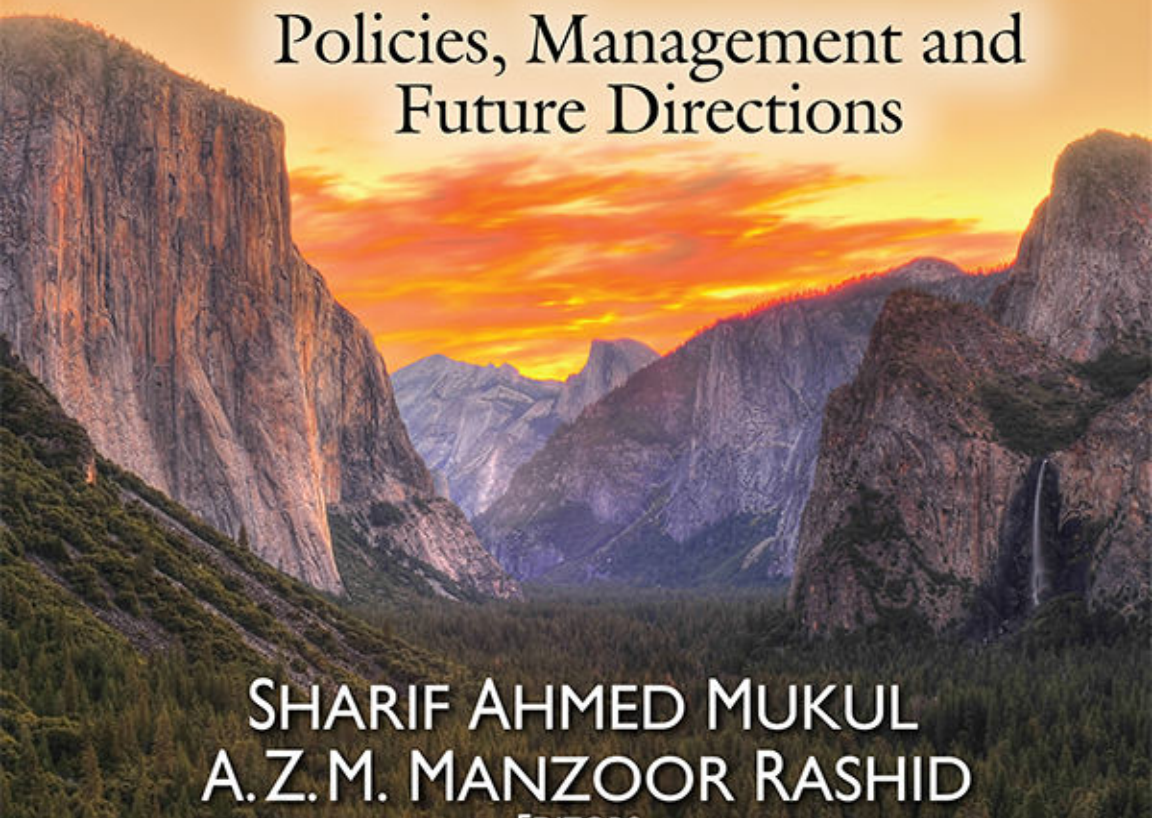

SHARIF AHMED MUKUL
A. Z. M. MANZOOR RASHID
EDITORS

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SHARIF AHMED MUKUL
AND
A. Z. M. MANZOOR RASHID
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Chapter 1

MANAGING PROTECTED AREAS IN A CHANGING WORLD: NEW INSIGHTS AND OPPORTUNITIES

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ABSTRACT

Establishment of protected areas (PAs) is one of the key global conservation strategies that currently cover approximately 15% of the earth's land surface. Globally, PA networks are designed to curb the growing anthropogenic pressures in areas with high biological diversity. Despite the importance of PAs in conserving the vanishing biodiversity and unique habitats, many of them are in critical condition due to poor

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governance thus functioning below the expected level. Moreover, in many developing countries, the PA coverage is below the global standard. Recognizing their contemporary role in conservation, governments have recently agreed to expand the global PA coverage to 17% by the year 2020 (Aichi target 11). This book with eight chapters from different regions of the world provides an overview of the PAs governance, institutional mechanisms, conservation benefits, limitations and challenges associated with their respective policy discourse, integrated management, and functional attributes. Protected areas expect to play an important role in the long run in conservation and protection of biodiversity and ecosystems particularly in countries where population pressure and habitat loss are high. Regular intervention, political commitment, and effective governance are essential for the sustainability of PAs across the world. Here, we also attempted to shed some light on future development clues for the sustainable management and monitoring of PAs worldwide.

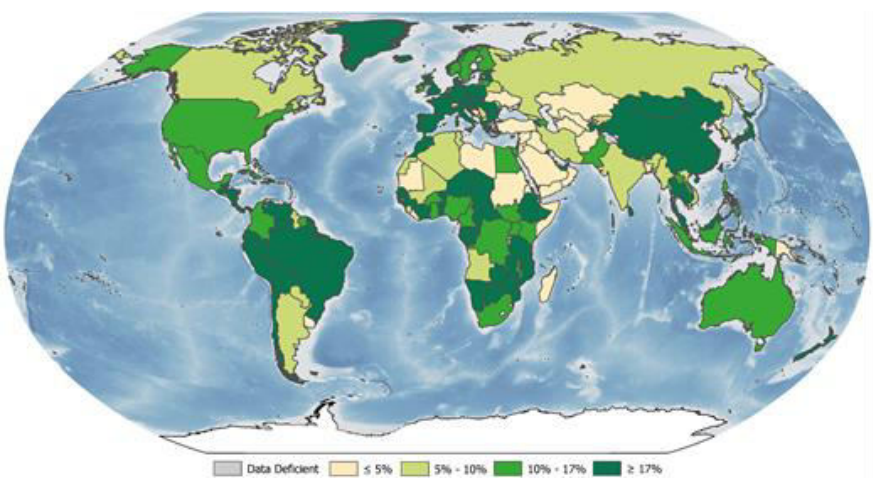
Keywords: conservation, governance, habitat loss, livelihood, eco-tourism, carbon credits

INTRODUCTION

Protected areas (PAs) are the cornerstone of the global conservation strategy and are critical for maintaining habitat integrity and species diversity (Bode et al. 2014; Laurance et al. 2012). The term "protected area" refers to any area of land or sea managed for the persistence of biodiversity and other natural processes *in situ*, through constraints on incompatible land uses (Possingham et al. 2006). Protected areas and its role in conservation are not new. For quite a long it has been in use in various forms and context (Watson et al. 2014). PAs undergo massive expansion both geographically and theoretically, and they now cover approximately 15% of the earth's land surface (UNEP-WCMC 2016; Geldmann et al. 2015; Figure 1). Recognizing their role in conserving biodiversity and unique habitats, the Convention on Biological Diversity (CBD) Aichi Target 11 recently calls for a substantial expansion in terrestrial and marine protected areas by 2020, with greater emphasis on the strategic expansion of global PA networks (Saout et al. 2013).

Source: UNEP-WCMC (2016).

Figure 1. Global protected area coverage (IUCN categories I-VI).



Source: UNEP-WCMC (2016).

Figure 2. Distribution of protected area systems around the world.

Despite of the growing consensus, many PAs are not functioning as intended and the management standards of a vast majority of PAs remains ambiguous thus regarded as "paper parks" (Geldmann et al. 2015). Substantial gaps remain in the PA coverage and the establishment is still influenced by the availability of land that is easy to protect and away from strategic areas for biodiversity (Venter et al. 2014). Figure 2 below shows the PAs coverage by

country across the world. It is clear that in many countries PA coverage and networks are still under the global standard to represent the unique habitats, flora, and fauna. There is also considerable debate on the extent to which PAs deliver conservation outcomes in terms of habitat loss and species conservation. Limited information regarding conservation outcomes in the context of different management inputs in PAs is quite common (Laurance 2013). A recent study by Gray et al. (2016) revealed that globally species richness is 10.6% higher and species abundance is 14.5% higher in PAs than in the surrounding landscapes. It is also true that in tropical developing region many PAs have been established after being modified by human activity and habitat conversion does not decline significantly following gazette notification of PA. In South Asia, for instance, about 25% of the land inside PAs are human-modified and within a dynamic socioecological systems (Clark et al. 2013). Establishment of PAs under such circumstances creates major conflicts with local communities posing significant management challenges (Mukul et al. 2010). This is largely due to the lack of recognition of traditional knowledge and practices, livelihood and dependency prior to the declaration of the area as PA (Chowdhury et al. 2014). In this regard, involvements of local communities in PAs management and incentives to communities dependent on PAs in many instances bring positive outcomes (Mukul et al. 2014; Rashid et al. 2013).

THE BENEFITS OF PROTECTED AREA

The primary benefit and the driving motivation of establishment of PAs is conservation of biodiversity and unique habitats (Venter et al. 2014). The role and practicality of PAs in conserving biodiversity are well recognized (Gray et al. 2016; Uddin et al. 2013). PAs also contribute significantly in curbing tropical deforestation and forest degradation (Andam et al. 2008). In fact, with deforestation advancing rapidly, many PAs in the tropics becoming the last refuges for their threatened species and critical ecosystems (Laurance et al. 2012). The recreational and aesthetic values are another two major aspect of their establishment and management. Nature-based tourism within PAs is one of the major sources of revenues from PAs worldwide (Karanth and DeFries 2011).

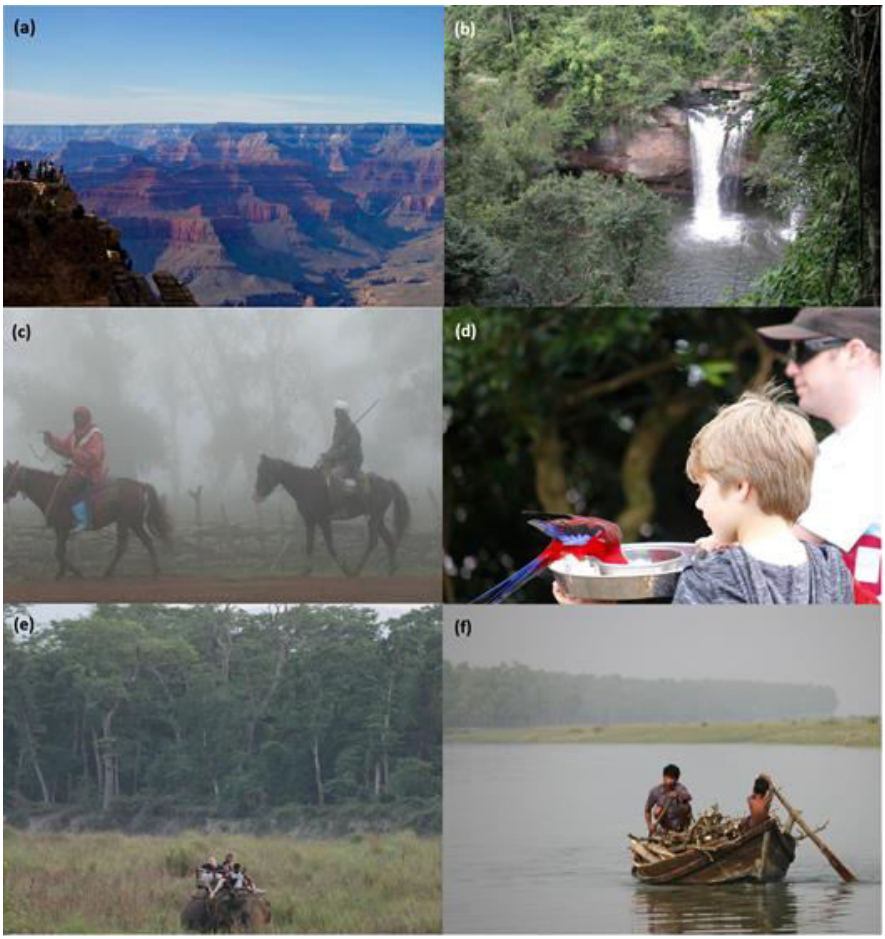


Photo credits: Sharif A. Mukul.

Figure 3. Local benefits and use of protected areas: (a) aesthetic and recreational use of Grand Canyon National Park, USA, (b) waterfall inside the Khao Yai National Park, Thailand – a major attraction to tourists, (c) monitoring of protected area by local communities in Bale Mountains National Park, Ethiopia, (d) visitors feeding birds in Lamington National Park, Australia, (e) Elephant ride by tourists inside Chitwan National Park, Nepal, (f) local extraction of firewood for domestic use in Nijhum Dwip National Park, Bangladesh.

The socio-economic benefits arising from PAs are different in developed and developing countries and mainly due to the differences in local socio-economic and cultural context (Andam et al. 2010). In both cases, the establishment of PAs brought some positive changes although the extent and

magnitude of changes may not be similar (Heagney et al. 2015; Andam et al. 2010). In developing world, the benefits from PAs are limited to only a few people and/or not evenly distributed. Local peoples here usually collect timber, non-timber forest products (NTFPs), firewood, bushmeat, medicinal plants, building materials from PAs which even sometimes go against the main principle of their establishment (Mukul et al. 2010). On the other hand, in developed world, the establishment of PAs usually influence the welfare of local communities by adding values to their life and livings (Heagney et al. 2015).

OVERVIEW OF THIS BOOK

A global zeal has already been established in regards to PA establishment and its governance for achieving the sustainable conservation and livelihood goals. This book is an attempt to revisit such development from the global point of view. Here we have accumulated eight chapters from seven different countries across the globe shedding lights on different attributes of PAs. This book believes to offer an international flavor to the readers with contemporary information on various aspects of PAs management.

Establishment of parks and protected areas provides an alternative to common pool resources that in mnay instances turns as the tragedy of the commons. The second chapter by Flemming (2017) attempts to combine some observations in regards to the governance mechanism for the accessibility of PAs currently open to all without any major restrictions. How growing populations are posing serious threats to biodiversity and natural resources of PAs is best described through using empirical examples from the global south. The chapter also tries to reveal the scenario through visitor's perception whose values for the parks are steadily eroded.

Rashid et al. (2017), in chapter 3, describes the development of a new paradigm of PA governance in Bangladesh. Good governance in natural resource management (NRM) is one of the most challenging tasks in developing countries that often inappropriately embedded in national policies and political agendas. This chapter, however, warned the practitioners and policy makers to be cautious in regards to external aid support and regulated conditioned of the donors to be taken care while introducing such approaches.

Nepal has undergone several policy reforms over the years to address multi-dimensional global conservation goals. In chapter 4, Bhattarai et al. (2017), attempted to explore a scenario in the country where conservation

without participation ended up with many socio-political and other related impacts. Forced displacement of inhabitants from PA especially indigenous communities has created many social impacts including a restriction on people's customary rights to access natural resources and their livelihoods.

Mayrhuber (2017), in chapter 5, investigated the forest resource utilization in the context of complex local situations within the boundaries of the Biligiri Rangaswamy Temple (BRT) Wildlife Sanctuary in Southern India. Based on an ethnographic research approach, the study revealed that the forest areas provide an essential source of provisioning and cultural services to the forest-dwelling people in the locality.

In the next chapter, Beita and Andreu (2017) manifested the role of local level policies for ecotourism development in Latin American context. Using Costa Rica as an example chapter 6 evaluates the issue of tourism management and involvement of local people in protected areas. Local policies related to tourism management and local people's involvements in PAs management are two important approaches that need to be evaluated with a view to identify their future challenges.

In a country like Bangladesh, the concept of forest protected area (FPA) for biodiversity conservation is rather new, started only in 1980's. In chapter 7, Mukul et al. (2017) provide an overview of FPAs of Bangladesh with their role and efficacy in biodiversity conservation. The majority of the country FPAs declared only in the recent years with still limited infrastructure, manpower and policy support. The authors concluded that there are ample opportunities to make the co-management a cost-effective strategy for FPA management in the country with sufficient access to local forest-dependent people in different alternative livelihood options.

Protected areas, now a days playing unique role in climate change mitigation through absorbing carbon in forest biomass and soil. Olupot et al. (2017), in chapter 8, manifested how land use and land cover (LULC) change in PAs influence carbon stock and CO_2 emission in Africa using Uganda as a case study. The authors' hypothesized that any change in the LULC or shifting away from native vegetation would lead a net reduction in carbon stock in PA. The chapter suggested for the revegetation and/or restoration of degraded forests with native tree species in order to increase the carbon sequestration capacity of local forests in PAs of Uganda.

Khapugin et al. (2017) in the last chapter attempted to reveal the status of vascular plants in PAs of Mordovia located in central parts of Russia. Massive tree felling inside the PAs and anthropogenic pressure have deteriorated the population status of important plant species in the country. The existing PAs

networks contribute to the conservation of rare and endangered plant species although a significant number of rare species has still remained outside the PA. The authors demonstrate that reorganization and strategic planning can result in an increase in rare and endangered plant species in the country's PAs network.

FUTURE OUTLOOK

With increasing global population and growing demand of land for agriculture and other use, protected areas are the last hope for earth's irreplaceable biodiversity hence should be managed as effectively as possible. Protected area networks should be designed appropriately to represent a country's unique ecosystem and biological resources that has also been revealed by Mukul et al. (2017) and Khapugin et al. (2017) in their studies. Local management in this regard must be strategically tailored to the specific biodiversity features of respective PA to secure maximum conservation outcome.

Right based approaches are the centre point of all development interventions thus local communities should be integrated into PAs governance with clearly defined rights and responsibilities. In India, Mayrhuber (2017) found that a large number of forest-dwelling people are still dependent on PAs for sustaining their livelihoods which largely determined by local regulation, tenurial arrangement, and customary rights. Exclusion of local people under such context may negatively influence the local livelihoods and thus threatens the ultimate aim of PAs establishment as revealed by Bhattarai et al. (2017) from Nepal. Rashid et al. (2017) also emphasized the need for people-centred approaches in PAs governance, although the authors also encouraged for local funding sources and capacity building for the long-term success of PAs system with less dependency on donor and/or program support for such kind of initiatives.

Sustainability is another crucial determinant factor for the success of PAs like many other development projects. The ever increasing population are creating serious threats to PAs in the global south similar to the north in many cases with the limited value of people for local biodiversity and natural resources (Flemming 2016). Ecotourism is a major attribute of PAs management which with suitable national policy, regulation and local intervention could also secure the sustainability of the PAs system (Beita and Andreu 2016).

New dimensions and values need to be incorporated in the management of PAs keeping climate change and other global issues into consideration. Olupot et al. (2017) found that PAs in Uganda contribute substantially to climate change mitigation. Protection of native vegetation and restoration of degraded lands with native flora have the best potential for biodiversity and carbon co-benefits. The introduction of payment for ecosystem services within PA networks including carbon credits to local communities could be a future avenue.

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Chapter 2

GOVERNING THE ACCESSIBILITY OF PROTECTED AREAS

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ABSTRACT

The National Parks present another instance of the working out of the tragedy of the commons. At present, they are open to all, without limit. The parks themselves are limited in extent – there is only one Yosemite Valley – whereas population seems to grow without limit. The values that visitors seek in the parks are steadily eroded. Plainly, we must soon cease to treat the parks as commons or they will be of no value to anyone.

What shall we do? We have several options. We might sell them off as private property. We might keep them as public property, but allocate the right to enter them. The allocation might be on the basis of wealth, by the use of an auction system. It might be on the basis of merit, as defined by some agreed-upon standards. It might be by lottery. Or it might be on a first-come, first-served basis, administered to long queues. These, I think, are all the reasonable possibilities. They are all objectionable. But we must choose – or acquiesce in the destruction of the commons we call our National Parks. (Hardin 1968, p. p.1245)

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Keywords: demand management, protected natural areas, recreation, visitor impact

INTRODUCTION

The above quotation indicates that the issues this chapter seeks to address are not new. Nonetheless, almost fifty years after Hardin's seminal article was published, the problem of unrestrained recreational use of protected natural areas remains largely unresolved. As the popularity of nature-based tourism grows so too does pressure on the natural amenities upon which the industry is based. This pressure manifests itself in overcrowding and damage to the natural environment, both of which serve to reduce the value of the experience to visitors. Resource managers are, therefore, faced with the very difficult task of accommodating an ever-increasing number of tourists, while preserving the very qualities that tourists (and others) value. The primary purpose of this chapter is to conceptually explore demand management as a potential policy response to this problem. The chapter begins with a discussion of the impacts of recreational visitors on protected natural areas. Alternative frameworks and strategies for management are then presented, before the sub-strategy of managing demand is analysed in detail. This analysis begins with a relatively novel re-categorisation of demand management mechanisms to clearly distinguish between those mechanisms that manage demand and those that allocate visiting rights. Four demand management and four allocation mechanisms are identified, and arguments made for and against the use of each. The chapter concludes by noting that no mechanism is considered superior to the others in all respects and resource managers need to choose the most appropriate mechanism for their circumstances. This choice should be supported by robust research.

IMPACTS OF VISITORS ON PROTECTED NATURAL AREAS

Although the primary goal of protected natural areas is conservation, in many jurisdictions a key legislative objective is often to provide recreational opportunities in a natural setting. Although the consequences of visitor impacts may not be as severe as the impacts of previous human activities in parks (e.g., livestock grazing, forestry and mining) direct and indirect impacts

from recreational use of protected areas are widespread, and are of increasing concern as visitor numbers to protected areas continue to rise (Pickering and Hill, 2007).

It has long been recognised that there are two critical components of visitor impacts: impacts on the environment; and impacts on the quality of the recreation experience. The scientific study of visitor impacts on the environment has been termed 'recreation ecology' and there is a large body of research in this area. Reviews of the literature can be found in Leung and Marion (2000), Newsome, Moore and Dowling (2002), Buckley (2004, 2005) and Monz, Cole, Leung and Marion (2010). The study of the social aspects is similarly the subject of a considerable body of literature, with reviews by Shelby, Vaske and Heberlein (1989), Manning (1999) and McCool and Lime (2001).

In one of the few studies to review both the ecological and social recreational impact literature, Kuss, Graefe and Vaske (1990) conclude that there are five principles common to both. These principles are: (1) there is no single predictable response of the environment or of visitors to recreational use; (2) the various impact parameters (i.e., indicators used to identify changes in environmental or social conditions) are related to varying levels of use intensity, although the strength and nature of the use-impact relationship varies widely for different parameters; (3) one of the most important factors affecting use-impact relationships is the inherent variation in tolerance among environments and user groups; (4) activity-specific relationships represent a second major set of considerations affecting use-impact relationships (i.e., some types of recreational activity create greater impacts than others); and (5) the impacts of recreation are influenced by a variety of site-specific and seasonal variables.

Together these principles have two implications for managing protected natural areas for recreation. First, it is extremely difficult to draw cause and effect relationships between existing use and environmental or social impacts, and second, it is almost impossible to determine *a priori* the impact a change in the level, type or timing of recreational use will have on a particular environment or on the recreational experience. Both of these implications serve to make the resource managers' job exceedingly difficult.

Impact of Visitors on the Environment

The ecological significance of visitors' impacts is a function of both the characteristics of the impact and of the receiving environment. The most important visitor impacts on the environment are those that affect a large area, are intensive, are long-lasting, affect areas that are irreplaceable (in terms of ecosystem function) and affect species or communities that are rare or threatened (Cole and Landres 1996; Pickering and Hill 2007). Research into the environmental impact of the recreational use of natural areas is typically divided at the system level into the impact on terrestrial flora, terrestrial fauna and aquatic ecosystems.

Impacts on Terrestrial Flora

Distinction can be drawn between the impacts of tourism *infrastructure* and tourism *activities* on the terrestrial flora of protected natural areas. With regards to the former, although there tends to be limited tourism infrastructure within protected areas, there are often tracks, roads, viewing platforms, campsites, car parks, and sometimes visitor centres and accommodation. Although the total area allocated to infrastructure may be relatively small compared to the total area of the park, the impacts at that site are severe and often permanent. The most obvious and direct impact is vegetation clearance, however, damage is not restricted to the initial removal of native vegetation, there are usually indirect effects in adjacent natural vegetation. For example, a study comparing vegetation and soils on road verges and adjacent areas in the sub-alpine zone of Kosciuszko National Park in New South Wales, Australia (Johnston and Johnston 2004) found that soils on the road verges had significantly lower levels of humus, more gravel and sand, lower levels of nutrients, lower pH and electrical conductivity than soils sampled in the surrounding areas. Moreover, this and other studies (Pauchard and Alaback 2004; Worboys and Gadek 2004) illustrate how roads and tracks can act as corridors for the spread of weeds and pathogens, as well as contribute to the loss of native vegetation through reduced natural ecosystem function (Pickering and Hill 2007).

In addition to the impacts associated with infrastructure, there are a number of impacts associated with visitor activities, including those that require little or no infrastructure. The most obvious impacts from activities such as horse riding, walking, off-road driving and mountain biking include vegetation being crushed, sheared off, bruised and uprooted. Studies have found that the damage from these activities results in loss of plant height,

productivity (biomass), photosynthetic material and reproductive structures (flowers, fruit etc.) (Smith and Newsome 2002; Talbot et al. 2003; Whinam and Chilcott 2003).

An area of great concern is soil compaction. This can occur from a range of visitor activities including hiking, driving, mountain-biking and camping. Soil compaction can reduce the soil's capacity to support vegetation due to reductions in the macrospores of the soil. Fewer and smaller macrospores can limit air and water movements within the soil, leading to restrictions in the growth of roots and consequently affect plants' underground carbohydrate reserves (Alessa and Earnhart 1999). Soil compaction can also reduce seed germination rates through reducing the natural unevenness of ground surfaces, which provides protection to seeds, as well as by reducing the amount of organic matter, which may alter soil temperature and thus seedling growth rates (Sun 1990).

Direct impacts from human activities may be exacerbated by indirect impacts. These impacts can be self-sustaining, that is, they can continue to occur even in the absence of further use. Although there has been increasing recognition of the importance of indirect impacts of visitors on terrestrial flora in protected natural areas, there has been far less research on this topic (Buckley 2005). Over time, direct and indirect impacts of recreational use on plants and soil can change the species composition of an area, with plants better able to cope succeeding at the expense of those that cannot. This in turn has an impact on the wildlife species that are dependent on the less adaptive plants. The plants that do thrive in the new environment may represent the more competitive or resistant species of the original community or exotic opportunistic invaders (Kuss et al. 1990).

Impacts on Terrestrial Fauna

The negative effects of the recreational use of protected natural areas on terrestrial fauna can be grouped into three main categories: disruption; direct contact; and habitat alteration (including the provision of food) (Green and Higginbottom 2001). Wildlife disruption can be caused by a range of visitor activities, including noisy activities, spotlighting (the 17ractice of using artificial light to view nocturnal species) and directly approaching species to take photographs or observe. The mere presence of humans is often enough to disrupt some species and evidence of disruption may be subtle. For example, a study of Royal Albatross (*Diomedeasanfordi*) at Taiaroa Head on the Otago Peninsula, New Zealand, recorded no discernable impacts on individual birds

from tourists watching them, yet analysis of longer-term data revealed significant changes in the breeding colony (Higham 1998).

Recreational use of protected natural areas can lead to increased mortality and injury of terrestrial fauna, either through deliberate actions (such as hunting and the removal of problem animals) or by accident (through collisions with vehicles and the spread of disease). World-wide, recreational hunting is a large-scale activity and is subject to considerable, often emotive, debate. Concerns relate to unsustainable rates of exploitation, the effect on population structures, disturbance or mortality of non-target species and animal suffering. That hunting can cause population decline or even extinction of wildlife species is well documented, although this phenomena is largely related to subsistence or (illegal) commercial hunting, rather than hunting for recreation. Nonetheless, recreational hunting, in that hunters tend to target trophy male individuals, can have a substantial impact on population sex structures (Green and Giese 2004).

Recreational activity within protected natural areas has the potential to increase vehicle-related injury or death of terrestrial fauna by bringing more traffic into the area, habituating animals to traffic (thus making them less wary) and creating a positive attraction to vehicles due to the provision of food by visitors (Green and Giese 2004). For example, Jones (2000) provides evidence that a population of eastern quolls (*Dasyurusviverrinus*) was driven to extinction as a result of deaths associated with upgrading of a road at Cradle Mountain, Lake St. Clair National Park, Tasmania, Australia.

Alteration of species habitat, as discussed above in terms of recreational use impacts on terrestrial flora, has a clear and direct effect on those fauna species reliant on the altered habitat. For example, ground flora lost due to trampling can lead to the loss of insects dependent upon that flora. Habitat fragmentation brings problems of edge effects, reduces territory and home terrain, and may enhance access by feral animals, including competitors or predators of native wildlife (Green and Giese 2004).

The provision of food by visitors, either deliberately or unwittingly, is often considered a key recreational use impact on terrestrial fauna's habitat, on the basis that any augmentation of an animal's resources is essentially an alteration to its habitat. Food provided for animals can lead to a decline in health through not being nutritionally adequate or by spreading disease. There is also concern that wild animals could become so dependent on food provided by visitors that they lose the ability to forage for themselves (Green and Higginbottom 2001). Some animals become habituated and docile when fed frequently, but others become assertive and even dangerous.

Impact on Aquatic Ecosystems

The popularity of recreational activities that involve contact with water has grown considerably in recent decades, as has the impact of visitors on aquatic ecosystems. Major impacts include viral-bacterial contamination and associated public health hazards, turbidity and nutrient enrichment or eutrophication (an increase in ambient nutrient concentrations). With few exceptions, most reports suggest that water quality problems are use-level dependent; the greater the number of people using an area at any one time, the greater the risk of water quality deterioration (Kuss et al. 1990).

With regards to viral-bacterial contamination, recreational exposures to pathogens in the water environment may result in disease. Susceptible populations include people with reduced immune function, genetic susceptibility or lack of acquired immunity to locally endemic diseases (i.e., tourists). Pathogens particularly associated with the recreational use of water in protected natural areas (as opposed to public swimming pools, spas etc.) include: *Campylobacter jejuni*, one of the most common causes of bacterial gastroenteritis and most likely to be found in recreational waters contaminated by animal and human waste; *Vibrio vulnifcus*, a bacteria commonly found in marine and estuarine environments; and *Giardia*, an organism carried in the faeces of humans as well as domestic and wild mammals (Pond 2005).

Excessive nutrient additions from anthropogenic sources threaten the long-term health of many of the Earth's freshwater ecosystems. Land clearing, industrialisation and the use of fertilisers in agriculture have greatly accelerated the delivery of nutrients to lakes and rivers, thereby causing eutrophication. The most visible symptom of eutrophication is the formation of blooms of toxic algae. In pristine freshwater environments managed for conservation, the biological consequences of eutrophication are undesirable. In addition to the numerous health and social costs associated with degraded water resources, the aesthetic appeal of the aquatic system is also reduced (Carpenter et al. 1998; Hadwen et al. 2004).

Whilst the addition of large quantities of nutrients from human sources may result in highly visible biological responses, relatively minor nutrient additions can also have substantial ecological effects, particularly in oligotrophic (nutrient-deficient) freshwater systems. Soaps, detergents, sunscreens and biological wastes from recreational visitors have the potential to considerably alter the physical and chemical conditions of such systems. Very few studies have investigated the consequences of direct nutrient inputs from recreational users of freshwater sites. One exception is the work of Butler, Birtles, Pearson and Jones (1996) and their investigation of the impacts

of tourists on several popular swimming sites in oligotrophic streams in north Queensland, Australia. They found nutrient and algal concentrations to be significantly higher immediately downstream from tourist access points than they were upstream of those points. Their conclusion was that tourists, both through sediment re-suspension and urination, are likely to have contributed substantially to these elevated nutrient concentrations.

Finally, recreational fishing is known to have depleted some stocks of both target and non-target species. Generally, however, the effects of recreational fishing on wildlife populations are poorly understood (Smith and Pollard, 1996) and other habitat pressures, such as those discussed above, may be more important.

Impact of Visitors on the Recreation Experience

The second important dimension of visitor impacts on protected natural areas is the impact of use levels on the quality of the recreational experience. The so-called 'satisfaction models' (Heberlein and Shelby 1977) have theoretical foundation developed in economics by Fisher and Krutilla (1972) and in sociology by Alldredge (1973). Beginning with an assumption that, in wilderness settings at least, visitors to protected natural areas prefer low visitor densities, these authors demonstrate that the social carrying capacity of a recreational site can be found by equating the marginal benefit of allowing additional visitors with the marginal crowding cost that these visitors create. The choice of dependent variable, however, differs between the two approaches. Economists typically use willingness-to-pay, while sociologists frequently use a Likert scale measure of satisfaction.

Early empirical research based on hypothetical visitor density (Manning and Ciali 1980; Stankey 1973) supports the underlying assumption that satisfaction declines with increases in use levels. Subsequent research based on actual density, however, has failed to confirm this argument; as has research examining the relationship between contacts and satisfaction. In their comprehensive review of these studies, Kuss*et* al. (1990) conclude:

> On average, recreationists tend to be just as satisfied in high-use settings as they are in low-use settings. Satisfaction may be related to use levels, but the relationship is too complex to be measured with simple correlations between satisfaction and various indicators of use intensity.
>
> (Kuss et al. 1990, p. p.195)

Researchers offer a variety of explanations for this result. Some question the validity of satisfaction measures (Stankey and McCool, 1984), others point to the heterogeneity of visitors' preferences for crowding (Kuss et al. 1990).

Schreyer (1979), taking a socio-psychological approach, puts forward three explanations for visitors reporting high levels of satisfaction in the presence of crowding: visitors adjust their perceptions of the experience; visitors shift their priorities of expectations; and visitors change their behaviour. These explanations have led to a substantial body of literature exploring the strategies visitors use to cope with crowding, strategies generally considered to fall within three primary forms: displacement, the notion that visitors alter their patterns of recreation activity to avoid crowding, and are thereby displaced by users more tolerant of high use levels; rationalisation, the notion that visitors, having willingly selected, and invested time, effort and money in their recreational choice, may rationalise their experience and report high levels of satisfaction, regardless of conditions; and product shift, the notion that visitors who experience higher use levels than expected or preferred, may modify their definition of the recreation opportunity in line with the conditions experienced (Manning 1999; Manning and Valliere 2001).

In all, the link between level of use and the quality of the recreation experience, whether measured by willingness-to-pay or reported satisfaction, is not straightforward. Thus, two principal conclusions can be drawn. The first is that different recreationists seek different experiences in the wilderness, and the relationship between amount of use and experience quality varies with the experience being sought. The second is that the amount of use is only one of many variables that influence the quality of visitor experiences. Other use-related variables (mode of travel, group size, behaviour and timing of use) also influence quality. Management strategies can be devised that manipulate each of these variables. Consequently, management actions other than limiting use are an equally and often more effective means of dealing with recreation management problems (Cole and Stankey 1997).

FRAMEWORKS FOR MANAGEMENT

Large escalation in outdoor recreation in the 1950s and 1960s stimulated concern over the appropriate level of use of protected natural areas. This concern led to the development of a number of alternative management frameworks for addressing the issue. The first of these, and the base from which most of the subsequent frameworks have developed, was the notion of

recreational carrying capacity; that is, a pre-determined number of visitors, beyond which either the environmental or social impacts of visitation become too great. Research in recreation carrying capacity began in earnest with a conceptual monograph on the idea by Wager (1964) and an empirical study by Lucas (1964). By the early 1970s the contemporary three-dimensional view of carrying capacity as a function of environmental, social and managerial conditions was established (Brown et al. 2006; Manning 1999).

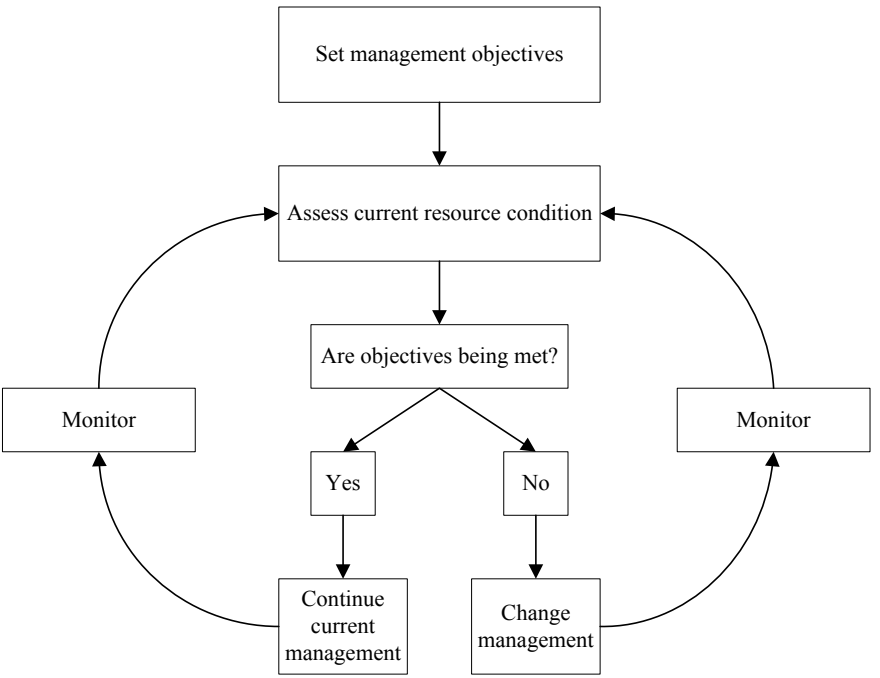
As intuitively appealing as the concept may be, the simple carrying capacity framework has, however, largely proven to be inadequate. Several authors have commented on the theoretical and practical shortcomings of attempting to place a numerical limit on the number of visitors to protected natural areas (McCool and Lime 2001; Seidl and Tisdell 1999; Stankey and McCool 1984; Wagar 1974). In one of the more critical papers, Lindberg, McCool and Stankey (1997) suggest that there are three fundamental limitations of the carrying capacity concept, as applied in recreation management. First, the authors contend that definitions of carrying capacity often provide little guidance for practical implementation and exist only in relation to an evaluative criterion that reflects an objective or desired condition. If the criterion is imprecise or unworkable, it will not be possible to specify a carrying capacity. This is exacerbated by the heterogeneity in visitor preferences for levels of use and by evidence that, for many, level of use bares little relationship with levels of satisfaction. The second limitation is that carrying capacity is perceived as a scientific objective, whereas it is in fact inherently subjective. The third limitation is that while carrying capacity typically focuses on use levels or number of visitors, management objectives typically relate to resource conditions.

This widespread dissatisfaction led to a re-assessment of the problem from one of: How many visitors are too many? To: What are acceptable levels of change from natural conditions, given the goals and objectives of the protected natural area in question? This reassessment subsequently led to the development of a number of alternative management frameworks, including the recreation opportunity spectrum and limits of acceptable change.[1]

It is worth noting that all of the frameworks provide a logical, structured approach for making management decisions. While there are variations in the terminology used, and sequence and number of steps, the core elements of each framework are the same. These are: step 1, defining the recreation

[1] Other management frameworks not discussed here include Parks Canada's visitor activities management framework, and the United States National Parks Services' visitor experience and resource protection framework. See Nilsen and Taylor (1997) for details.

opportunities to be provided; step 2, monitoring indicators to determine if current conditions meet standards of quality; and step 3, implementing some type of management when and where monitoring suggest the standards have not been met (Manning 1999). This process is depicted in Figure 1.



Source: Adapted from Ormsby, Moscardo, Pearce and Foxlee (2004).

Figure 1. Simplified visitor management framework process.

Recreation Opportunity Spectrum

The recreation opportunity spectrum was the first to be widely adopted and is incorporated into many subsequent frameworks, including limits of acceptable change. The concept is based on the precept that different recreationists engage in specific recreation activities in specific settings (each described in terms of physical, social and managerial attributes) in order to attain desired experience outcomes (Virden and Knopf 1989). Thus, managers should aim to provide a spectrum of desired recreation opportunities to satisfy the diversity of visitor motivations (Manfredo et al. 1983).

The recreation opportunity spectrum is comprised of a number of categories of protected natural areas (or sub-areas within protected natural areas) for recreation, ranging from the most natural to the most developed. For example, the Great Barrier Reef Marine Park Authority in its management plan for the Whitsundays region in Queensland, Australia has five categories ranging from *protected* to *developed*. Each category has a corresponding limit on both vessel length and group size (Ormsby et al. 2004).

The key strength of the recreation opportunity spectrum framework is that it promotes consideration of providing a diverse range of recreational opportunities for visitors and encourages planners to consider management on a regional, rather than an individual, area scale (Brown, et al. 2006). Limitations of the framework include that its setting indicators and their criteria must be accepted by all managers within a region (Nilsen and Taylor 1997) and that the perceptions of visitors and managers of different classes may vary (Watson et al. 1997).

Limits of Acceptable Change

Limits of acceptable change is an approach developed as an alternative to the carrying capacity concept and an extension of the recreation opportunity spectrum. In comparison to earlier concepts, limits of acceptable change is a framework that designates more specific management objectives and standards for natural and social conditions in a protected natural area. The aim of this framework is to keep change due to human-use within acceptable levels in order to maintain the desired quality of an area's social and biophysical characteristics (Hendee et al. 1990; Stankey et al. 1985). The limits of acceptable change process contains nine steps based on identifying and monitoring a small number of indicators that specify an acceptable level of naturalness and experiential quality for different environmental settings (Ormsby et al. 2004).

The strengths of the framework include that it has proven to be a useful vehicle for deciding the most appropriate resource and social conditions in protected natural areas (Hendee, et al. 1990) and that it provides a strategic and tactical plan for an area based on defined limits of acceptable change for each opportunity class (Nilsen and Taylor 1997). Key criticisms of the process are that it takes a considerable amount of time to implement, the focus on current issues can distract from long-term strategic objectives and there is less

public involvement in the process than in other frameworks (Hendee et al. 1990; Nilsen and Taylor 1997).

Simulation Modeling of Outdoor Recreation

Simulation modelling of outdoor recreation began in the 1970s and was developed further in the early 1980s. The first generation model, known as the wilderness travel simulation model, was designed to provide estimates of the number, type and location of encounters between recreation groups in a park or protected natural area. The model required input variables such as typical travel routes and times, arrival patterns and total use levels. Outputs included the number of encounters between visitor parties of various types as well as the date and location of encounters. Despite early tests establishing the validity of the approach, the model soon fell into disuse, largely due to the cost and difficulty of running computer simulations at that time (Wang and Manning 1999).

Advances in computer technology, coupled with the observation that traditional frameworks such as limits of acceptable change are generally reactive in nature (that is, management actions are triggered only once it is observed that quality standards are not being met) has led to the emergence of a second generation of computer simulation models. By estimating the level of visitors that will cause quality standards to be violated and ensuring that such levels are not reached, these new models allow management frameworks to be more proactively applied.

The new generation of models has been applied in several protected natural areas, predominantly in the United States (Lawson et al. 2003; Wang and Manning 1999). These studies suggest that computer simulation has promise as a tool for recreation research and management. However, longer-term studies in a variety of recreational settings are needed before the validity of the approach can be firmly established. Further, to date, the overwhelming focus of computer simulation models in recreation research has been on social, rather than ecological, impacts; this area too deserves further consideration.

STRATEGIES FOR MANAGEMENT

Once a management framework has been selected and applied to a protected natural area, the next step is to choose a management strategy to give

effect to the outcome of the management framework process. As presented in Figure 2, at the broadest level there are three strategies available.

One strategy is to exclude all recreational users, thus reserving the area for conservation and scientific use only. This is the case where the management framework process has concluded that the area is too ecologically or culturally valuable, or too vulnerable, to allow recreational use. In contrast, an alternative management strategy is to allow unlimited recreational use of the area, both in terms of visitor numbers and type of activity. The third management strategy is to allow some recreational use, subject to management controls on numbers, types or location of recreational activity.

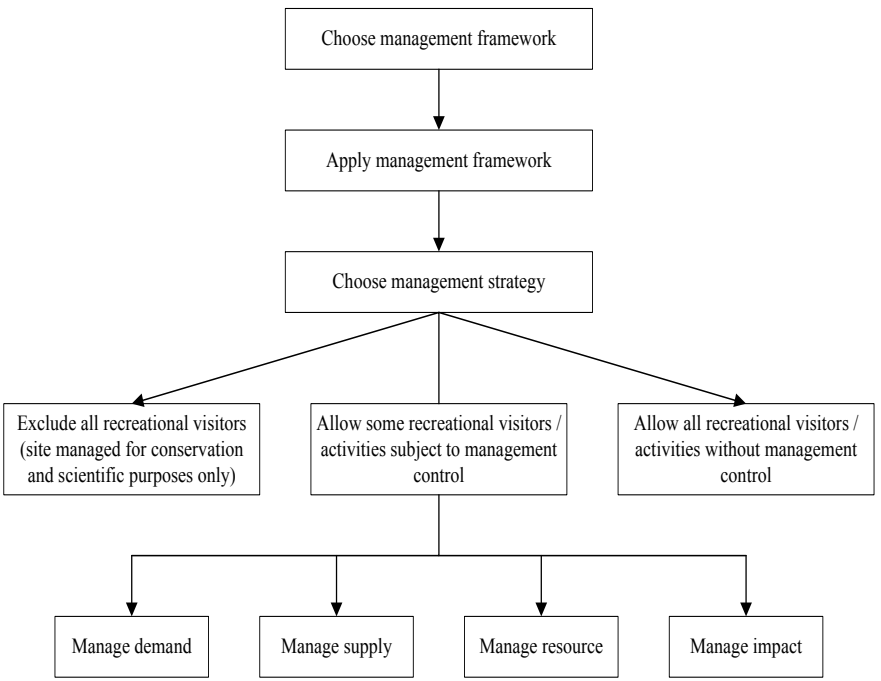


Figure 2. From framework to strategy and sub-strategy.

Given the choice of a management strategy allowing some recreational use subject to management controls, four sub-strategies can be identified. The first is to manage the *demand* for visitation, for example through the imposition of a use limit or visitor cap. This sub-strategy is the focus of this chapter. The other three sub-strategies are: managing the *supply* of tourism or visitor opportunities, for example by increasing the space or time available to

accommodate more use; managing the *resource capability* to cope with use, for example through hardening the site or developing facilities; and managing the *impact* of use, for example by dispersion or concentration (Eagles et al. 2002; Manning, 1979). These sub-strategies are not considered further here.

MANAGING DEMAND FOR ACCESS TO PROTECTED AREAS

The practice of managing demand (or rationing access) to protected natural areas has been controversial since it first became widespread in the United States in the 1970s and the imposition of policies designed to reduce, or manage, demand for access to natural areas remains one of the most contentious issues in protected area management today. Opinions on the subject range widely. At one extreme are those who believe that natural areas will be irreparably damaged unless use is controlled and limits should be imposed wherever increasing use threatens the environment (Freimund and Cole, 2001). At the other extreme are those who believe that unrestricted access to protected natural areas is a fundamental human right and imposing a rationing mechanism is a violation of that right.[2]

Debate on Managing Demand

Those who support the use of demand management or rationing mechanisms point to a body of literature indicating that, when faced with protected natural areas being used beyond capacity, visitors are generally supportive of use-limits. In one of the earliest studies, Fazio and Gilbert (1974) find that 86 percent of successful and, somewhat remarkably, 80 percent of unsuccessful applicants for permits to visit Rocky Mountain National Park in Colorado are supportive of rationing. This result is supported by Stankey (1979) who finds that 82 percent of potential visitors to San Bernardino National Forest in southern California (that at the time was subject to use-limit quotas) are supportive of the need for rationing; including 75 percent of those who were excluded from visiting the site due to the rationing policy. Support for the concept of rationing use when sites are being used beyond capacity has

[2] Henderson, R. Director, Tourism and Visitor Management, Parks Division, QPWS. Personal communication. 3 June 2006.

subsequently been found by Cole, Watson, Troy and Spildie (1997) and Cole (2001).

As previously noted, there are two components of visitor impacts on protected natural areas: impacts on the environment; and impacts on the quality of the recreation experience. Thus, there are two potential *rationales* for managing demand. Very little research has been carried out exploring which concern dominates when visitors indicate support for demand management policies. Stankey (1979) finds neither concern dominates, with 44 percent of respondents supporting restrictions due to the need to protect the environment and 42 percent due to the need to protect the experience.[3] Hall (2001), however, suggests that there may be greater levels of support for limits based on biological need. This is supported by the findings of Fleming and Manning (2015) who employ a choice experiment to assess to what extent visitors to Lake McKenzie, Fraser Island, Australia, are willing to forego access to publicly owned protected natural areas in order to ensure less crowding and/or better environmental outcomes. The authors conclude that visitors are, in general, willing to trade off some degree of access rights for better environmental outcomes and reduced crowding, but particularly for the former.

The arguments put forward by those who oppose the imposition of rationing or demand management policies are extensive. Many argue that indirect (non-regulatory) measures, for example education, should be attempted before regulatory measures and that these might succeed in alleviating the problem without unnecessarily impinging on the rights of visitors (Hall 2001). Hendee et al. (1990) go further, concluding that although use-limits may be the only alternative in some cases, "…direct rationing of use should be a last resort after every other appropriate approach has been exhausted" (p.406).

A primary concern is the distributional consequences of rationing policies. As discussed below, depending upon the rationing or allocation mechanism used, use-limits favour certain visitors over others. At a more primary level, the imposition of rationing policies favours those tolerant of regulation and in search of solitude, at the expense of those who favour freedom and spontaneity; of course the reverse is true if the decision is made *not* to impose rationing policies (Hall 2001).

[3] Other rationales given for supporting restriction policies were: 'save for future generations' (nine percent); 'good idea, but needs modification' (three percent); and 'a necessary evil' (two percent).

One of the more compelling arguments against the use of rationing or demand management mechanisms is evidence of a non-linear relationship between use and impact, either on the environment or on the recreational experience. In relation to the former, research has shown that most impacts occur at relatively low levels of use, with many impacts exceeding thresholds after very little use and further use having very little additional impact (Cole 1992; Cole and Fichtler 1983). This suggests use-levels would have to be severely reduced to bring about noticeable improvements in the environment.

Two further arguments against rationing access are that use-limit policies, as commonly implemented, provide no incentive for individual visitors to reduce impacts (since merit is generally not a basis for allocating use) and that use-limits in one area may simply lead to visitors moving elsewhere, displacing, rather than fixing, the problem (McCool 2001).

A Re-Categorisation of Demand Management Mechanisms

The leisure science literature typically identifies five mechanisms or management practises that can be used to allocate or ration scarce recreational resources: pricing; queuing; merit; advanced reservation; and lottery (cf. Manning 1999; Shelby and Heberlein 1986; Stankey and Baden 1977). This list of mechanisms is neither exhaustive, nor entirely consistent with a supply-demand framework. Thus, this list is re-categorised and extended below.

To illustrate the logic behind this re-categorisation, assume there is a unique recreational site with a demand curve D_0 and a pre-determined desired maximum level of visitation Q^{MAX}. This site is subject to a nominal entry fee P_N and has a current level of visitation Q_0. We therefore have a situation of excess demand (point A), depicted in Figure 3.

Restricting our attention to demand management strategies only, there are three means of reducing the level of visitation to the maximum desired level. The first is to raise entry fees to P*, as depicted by point B in Figure 4.

A particular form of rationing by price, peak pricing, works by charging a higher entrance fee during times where demand for access to the recreational site is typically higher, for example weekends and public holidays. That is, there are two demand curves, one for off-peak periods and one for peak periods. In order to maintain visitation at Q_{MAX}, two prices are needed, with the peak-price exceeding the off-peak price. This is depicted by points A (off-peak) and B (peak) in Figure 5.

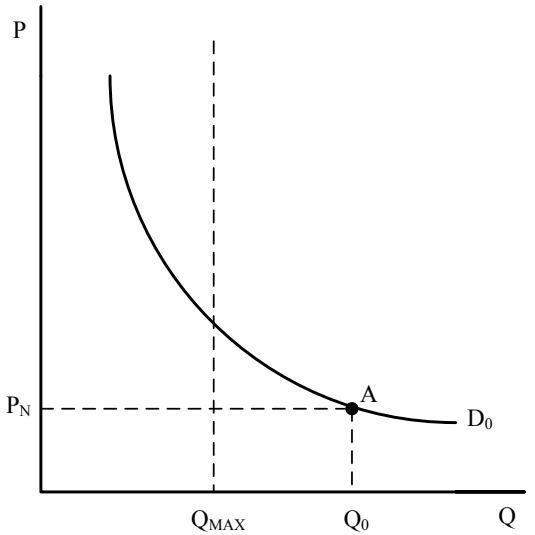


Figure 3. Excess demand.

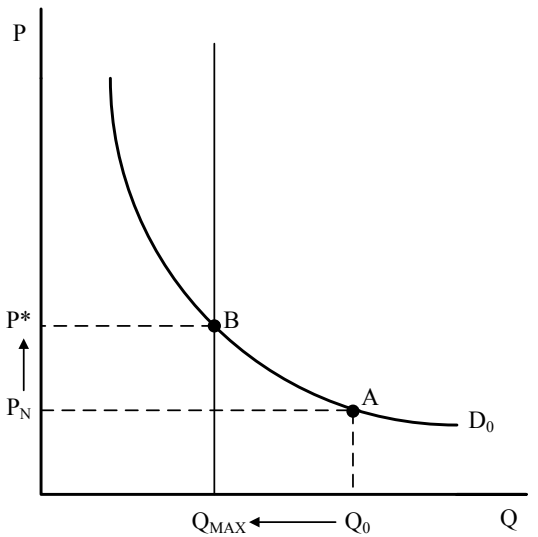


Figure 4. Rationing by price.

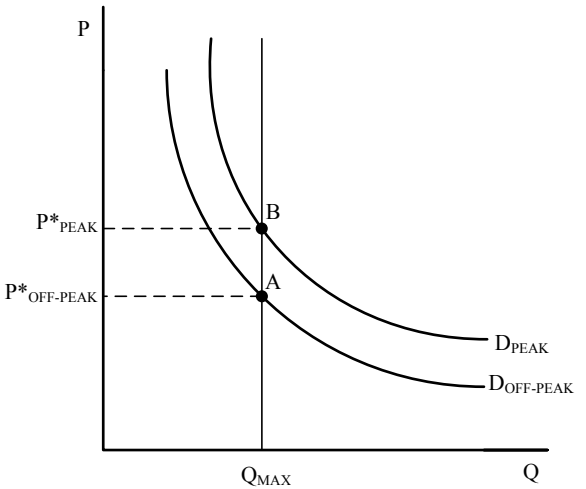


Figure 5. Peak pricing.

The second means of reducing the level of visitation to the maximum desired level is to reduce demand for access to the site, as depicted by point B in Figure 6. The two methods of achieving this considered here are increasing the difficulty of accessing the site and lowering the profile of the site (or raising the profile of alternative sites).

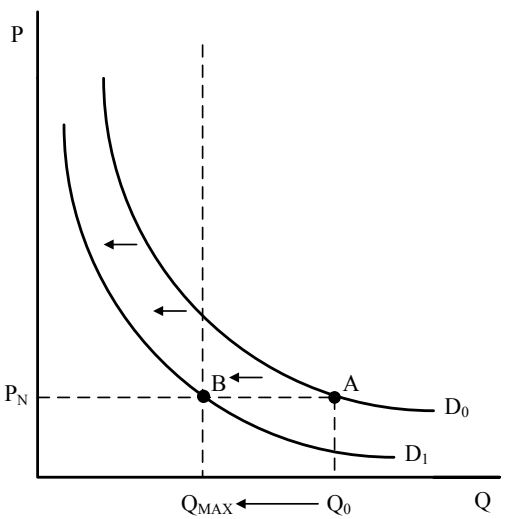


Figure 6. Reducing demand.

The final means of reducing the level of visitation is to require visitors to obtain a permit to visit the site and then restrict the number of permits issued (i.e., impose a quota). In practice this is by far the most common means of rationing access to protected natural areas, however the problem then becomes one of allocating these permits among potential visitors. As depicted in Figure 7, there is a shortage of permits represented by the line CD. Four allocation methods are considered: queuing; advanced reservation; lottery; and merit.

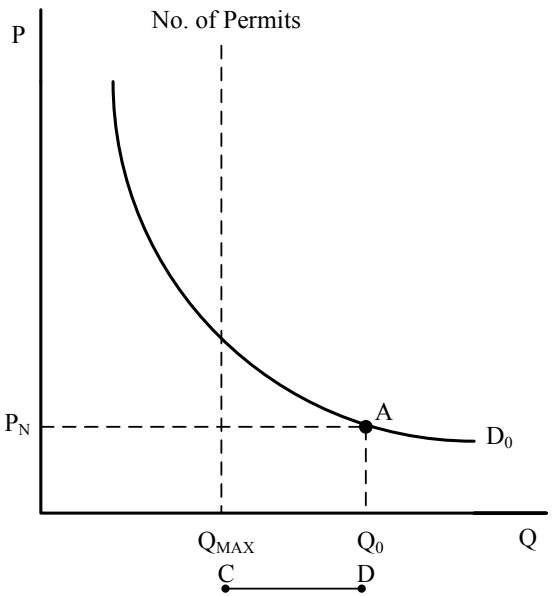


Figure 7. Use of quotas.

In summary, there are four demand management (or rationing) mechanisms (price, physical constraints, demarketing and quotas) and, if imposing a quota is chosen, four allocation mechanisms (queuing, advanced reservation, lottery and merit). The distinction between demand management and allocation mechanisms is typically not made in the leisure science literature. The remainder of this chapter addresses each demand management and allocation mechanism in turn, with arguments made for and against each mechanism.

RATIONING BY PRICE

Few topics receive as much attention in recreation economics as user and entrance fees. While the former, charges for such things as campsites, barbeques and other facilities, are widely accepted (Bowker et al. 1999), the concept of being charged simply to enter a protected natural area remains a matter of controversy. For example, in an examination of attitudes to entry fees to National Parks, 67 percent of respondents reply that they do not think visitors should have to pay to visit Queensland's Lamington National Park, Australia (Wilson and Tisdell 2003). Nonetheless, the imposition of entrance fees is widespread, with fees being charged at approximately 50 percent of the world's natural areas (Giongo et al. 2004).

Arguments on Price Rationing

Arguments in favour of the introduction of entrance fees can be put forward on three grounds: efficiency; equity; and revenue (More, 1999). The efficiency argument centres on the notion that rationing by price ensures those who are willing-to-pay for access are allowed entry and those who are not willing-to-pay are denied entry, thus allocating the resource towards those who value it most highly. Furthermore, if the entry fee is set equal to marginal (including crowding and environmental) cost, an optimal level of use will result (Binkley and Mendelsohn, 1987; Rosenthal et al. 1984).[4]

A further efficiency argument is that entrance fees, through removing the subsidisation of public areas, may encourage private provision of recreational services (Harris and Driver, 1987). Moreover, Tisdell (1988) suggests that low or no fees may induce private tourism operators to capture resource rents that would otherwise accrue to park managers.

Equity is perhaps the most powerful argument in favour of entrance fees (More, 1999). The argument is straightforward; those who use recreational

[4]A problem with setting entry fees equal to marginal cost is that, in the presence of economies of scale, marginal cost pricing may not generate sufficient revenue to cover total costs. A number of solutions to this problem have been put forward. The first is to make up any revenue shortfall from another source (typically government). A second solution is to set entry fees equal to average cost (although this fails the efficiency test). Two-part pricing, where an entry fee set equal to marginal cost is accompanied by a flat fee paid by all those wishing to visit the site, is another solution. Perfect price discrimination, where each visitor is charged his or her maximum willingness-to-pay, and Ramsey pricing (Ramsey, 1927) where fees are set according to visitors' price elasticity of demand, round out the options.

sites (and therefore presumably receive the greatest benefit from their provision) should bear a greater proportion of the associated costs. This argument is strengthened if use of the site is dominated by members of high-income households or where protected natural areas in developing nations are predominantly visited by high-income tourists from developed nations. In these cases, under-charging for entrance to publicly funded sites represents a redistribution of wealth towards the wealthy (Alpizar, 2005; Bowker, et al. 1999; Crompton and Lamb, 1986).

An often cited, and obvious, benefit of entrance (and user) fees is the revenue they obtain for resource managers, in many cases offsetting otherwise declining budgets. This revenue can then be used to increase both the quality and quantity of recreational services offered (Harris and Driver, 1987).[5] In addition to increasing resource manager's budgets, fee proponents claim this revenue has political benefits, namely signalling the value of recreation. This places recreation on a more equal footing with commodity-based alternatives such as forestry, grazing or mining and ultimately legitimises recreation management and nature conservation (Binkley and Mendelsohn, 1987; Harris and Driver, 1987).

While the recreation economics literature is generally supportive of entry fees, this is not the case of the leisure science literature. The arguments against entry fees (and in some cases user fees more generally) fall into two categories: equity; and collection costs.

Opponents of fees raise two equity concerns; equity with respect to income and equity with respect to geography (Williams et al. 1999). The income concern is that fees may be inequitable because they discriminate against those who cannot afford to pay, that is ability (as opposed to willingness) to pay may make it more difficult or impossible for those on low incomes to use recreational facilities (Harris and Driver, 1987; Reiling, et al. 1988; Walsh et al. 1989).

Counter to this is the argument put forward by Cordell (1985) who suggests that fees make up only a very small component of the total cost of visiting a recreational site and are therefore unlikely to discriminate against low-income users; largely because these users are already excluded due to other associated costs such as transport and equipment costs. Empirical support for either of these hypotheses is mixed. Manning, Callinan, Echelberger, Koenemann and McEwen (1984) and Leuschner, Cook,

[5] There is a suggestion, however, that revenue gathering is a 'zero sum game' where any increase in revenue from fees is met by a subsequent reduction in funding from other sources (Reiling et al., 1988).

Roggenbuck and Oderwald (1987) conclude that fees do not discriminate against low-income users, however, Bamford, Manning, Forcier and Koenemann (1988) find some evidence of a discriminatory impact.

A more significant equity impact appears to be related to the distance people live from the site. Specifically, the travel costs associated with access to protected natural areas create a geographically uneven distribution of fee impacts. Fees tend to have a proportionately higher marginal cost for locals and therefore tend to disproportionately reduce use of the recreational site by those who live nearby (Walsh et al. 1989).

The final argument against entry fees is simply that fees are difficult, time consuming and expensive for resource managers to collect, with costs potentially outweighing, or at least accounting for a substantial proportion of, any revenue collected. This is especially true if an area is remote and has a number of entry points (Cullen 1985; Harris and Driver 1987).

PHYSICAL CONSTRAINTS

Reducing the level of visitation to a nature-based recreation site by making access more difficult was first suggested by Scitovsky (1964), who put it forward as a more equitable solution to over-visitation than charging an entrance fee; a position later supported by Hardin (1969). The rationale behind such an approach is straightforward; by increasing the time and physical exertion 'price' of access, demand will be reduced.

Arguments on the Use of Physical Constraints

Observing that policies to ration use, such as closing parking areas close to popular sites, demolishing foot bridges and restricting mountain bike use along access tracks (often collectively known as 'long walk-in' policies) are attractive to many in the sense that they avoid 'pricing the hills,' Hanley, Alvarez-Farzio and Shaw (2002) use a random utility model to predict the impact on welfare and visits of these policies compared to the imposition of car parking fees at popular rock climbing sites in Scotland. The authors conclude that long walk-in policies are a cost-effective means of reducing visits at a given site. They note, however, that the implementation of such policies can be difficult, both in terms of enforcement and because of concerns over safety.

Richardson (2002a, 2002b) analysing the provision of walking track recreational opportunities in New Zealand, demonstrates that in the face of increasing congestion-causing demand from foreign visitors, and in the absence of pricing (prohibited under the relevant New Zealand legislation[6]), reducing the ease of access to sites can increase (domestic) visitor welfare; a result driven by an assumption that foreign visitors have a greater preference for ease of access than domestic visitors. Alternatively, in a two-good case, the author advocates provision of two levels of quality, a 'high' quality good for foreign visitors and a 'low' quality good for domestic visitors (where quality is defined in terms of ease of access and level of amenity rather than quality of the environment). While such 'environmental apartheid' may seem unpalatable, Richardson notes that such an outcome seems to be evolving in practise, as the Great Walks[7] (those with, among other characteristics, the highest levels of amenity and access) are increasingly dominated by foreign visitors. Richardson tempers this recommendation however, by noting that such policies are second-best, the first-best solution is to use (differentiated) monetary prices.

In a less favourable consideration of the relative merits of using physical constraints or 'effort' as a rationing mechanism, Cullen (1985) puts forward a number of arguments against such an approach. First, on the grounds of efficiency, he notes that effort expended by recreationists represents a real cost to society, but (unlike entry fees) is not an expenditure captured by suppliers. A further criticism is that measures to decrease access, such as closing roads and removing bridges, are often costly and provide large discrete shifts in ease of access; suggesting physical constraints are a rather inflexible tool for managing excess demand. The author also notes that the distributional impacts of these measures can be severe; skewing recreational participation in favour of the young and able, or those with low time costs. Moreover, the existence of market priced substitutes (helicopter access for example) is likely to result in low-income users paying by effort and high-income users paying by monetary price. Cullen also notes that a possible side-effect of lowering the accessibility of sites may be to encourage extended use of protected natural areas, as people spread the fixed effort costs over a longer time period. A final concern with this rationing mechanism is that closing access roads may lead to increased

[6] The National Parks Act 1980, the Reserves Act 1977 and the Conservation Act 1987.

[7] New Zealand's premier walking tracks, made up of the Lake Waikaremoana Track, the Tongariro Northern Circuit, the Whanganui Journey, the Abel Tasman Coast Track, the Heaphy Track, the Routeburn Track, the Milford Track, the Kepler Track and the Rakiura Track.

environmental damage as recreationists (especially those in 4WD vehicles) seek alternative un-official off-road routes.

DEMARKETING

The term 'demarketing' was first used by Kotler and Levy (1971) and refers to '…that aspect of marketing that deals with discouraging customers in general or a certain class of customers in particular on a temporary or permanent basis' (p.75). Globally, many protected natural areas, including those under stress from over-visitation, remain heavily promoted as recreational destinations by both private tourism operators and public tourism and park agencies, suggesting that demarketing deserves some consideration as a potential demand management strategy.

In their seminal article, Kotler and Levy (1971) cite the case of Bali seeking to restrict visitation to higher income visitors, thereby forgoing mass tourism. In a similar vein, Clements (1989) discusses demarketing as one of the strategies employed by the Cyprus Tourism Board to discourage rowdy young tourists from visiting Cyprus, in favour of older middle to high income groups. More common examples of the use of demarketing can be found in campaigns against social ills such as smoking, gambling and drink driving.

In one of the few attempts to put forward demarketing as a visitor management tool for natural recreational sites, Beeton and Benfield (2002) note that the British National Trust, in an effort to reduce demand, ceased all paid advertising for the Sissinghurst Castle Garden in Kent. Visitor levels did indeed fall and subsequent surveys suggest that the majority of remaining visitors had come because they already knew of the gardens or had been urged to visit by family and friends. More recent research has explored the opportunities for demarketing to help reduce conflict between users on multi-purpose trails in Australia and the United States (Beeton 2003, 2006).

Arguments on Demarketing

Potential advantages of demarketing are that it is a relatively non-intrusive and flexible demand management tool. A potential drawback, however, is that it would seem to bias future visitation towards existing or nearby users, i.e., those already aware of a protected natural area's existence and attributes. There is also the issue of whether demarketing simply displaces the problem,

as those visitors discouraged (or not actively encouraged) from visiting a site choose other nearby destinations. In all, the use of demarketing in protected area management is still in its infancy and further research is needed before definitive conclusions can be made about the advantages and disadvantages of the approach in this context.

QUOTAS

Imposing a quota, or cap, on the number of visitors permitted entry to a protected natural area is perhaps the rationing mechanism most closely aligned with the notion of recreational carrying capacity. Typically this approach relies on the use of a permit system, whereby the number of permits issued per period of time (often per-day or, in the case of recreational hunting and fishing, per-season) is limited to some pre-determined level.

The principal advantage of this mechanism is that it affords a level of certainty that the previously discussed rationing mechanisms do not. That is, resource managers are able to set a precise upper bound level of visitation. Unfortunately, this is also one of the mechanism's weaknesses, as the carrying capacity of a site needs to be established with a corresponding level of precision.

The impact on potential visitors of such a system depends on how much demand exceeds the supply of permits, as this affects the probabilities of visitors being denied access. Clearly the impact increases as the likelihood of obtaining a permit decreases. As noted earlier, permits can be allocated by queues, advanced reservation, lottery or merit. Each allocation mechanism has its own strengths and weaknesses and these are briefly discussed below.

Queuing (First-Come, First-Served)

The use of an on-site queue or first-come, first-served, allocation mechanism is in some respects similar to rationing by price or by physical constraint. This is because the mechanism imposes a price on the use of the recreational resource; however the price is in terms of time rather than money or effort.

Arguments in favour of using queues to allocate access rights to protected natural areas can be made on the grounds of equity and efficiency. Equity in

that time is more evenly distributed than income and efficiency in that places are allocated to those who value (in terms of time) the resource most highly.

Counter to these arguments is the observation that, while time may be allocated evenly among individuals, available leisure time is not. Queuing therefore discriminates against those with a high opportunity cost of (leisure) time in favour of those with low opportunity costs (typically those on low incomes or outside the labour force). This allocation mechanism also favours those who live close to the recreational site, as the costs associated with travelling to the site are much lower, and therefore the risk of being turned away at the entrance is of less concern than for those travelling from afar.

Another disadvantage of this approach is the potentially high administrative costs imposed on resource managers. Further, like the objection to physical constraints noted by Cullen (1985), time costs impose a real cost to society, but are not expenditures captured by suppliers. In all, the use of on-site queues does not appear to have a great deal of support from either users or managers (Shelby et al. 1982).

Advanced Reservation

Advanced reservation is the most common non-price allocation mechanism and is used to allocate access to a wide variety of goods and services, including theatre and sports events, restaurants, and, increasingly, nature-based recreational opportunities. In the latter setting it has been demonstrated to be the most acceptable allocation mechanism to users and managers alike (Shelby et al. 1982). Of all the allocation or rationing mechanisms considered in this chapter, advanced reservation has perhaps the least distributional impact, with income, age and mobility having little bearing on ability to gain access to the recreational site.

Unfortunately there are some potential difficulties with this approach. In particular there is the problem of ‘no-shows’ and strategic behaviour by people making multiple reservations to maintain the option to visit a site. Unless no-shows can be easily re-allocated, an area may be underutilised, even at times when demand for entry is very high (Stankey and Baden, 1977). A potential remedy for this problem is to charge booking fees at a level equal to, or greater than, the option value, thus reducing incentives for visitors to engage in this behaviour.

Another criticism of this approach is that, unlike entrance fees, allocation of places does not necessarily discriminate against users on the basis of how

much they value the resource; although it can be argued that by demonstrating a willingness to book and plan in advance, users are indicating that they value the site more highly than those who choose to visit on the 'spur of the moment.'

Finally, there is the issue of administration costs, advanced reservation involves considerable effort on behalf of the site's manager in terms of keeping track of applications, advising applicants of whether they have been successful or not, and dealing with and re-allocating cancellations.

Lottery

A lottery in its simplest form is a random, unbiased selection of applicants, where each applicant has an equal probability of being selected (Shelby and Heberlein 1986). Its use as an allocation mechanism has a long history. In the Old Testament, lottery is deemed a fair method of dividing inherited land (Numbers 33:54). Lotteries are also used to allocate bads. In another biblical example, Jonah, chosen by lot, is thrown overboard during a storm in an attempt to appease God (Jonah 1:7). In cases of mass desertion, Roman army leaders would select by lot every tenth man to be executed (decimated) (Boyce 1994).

Lottery as an allocation mechanism remains in use today. Jury selection is an obvious example, others include the allocation of places in schools (Saulny 2005) and medical facilities (Robinson and Peacock 2004) and the allocation of takeoff and landing rights at airports (Brannigan 2000).

In a recreational setting, the allocation of resources, in particular hunting rights, by lottery is widespread in the United States and Canada.[8] Scrogin and Berrens (2003) cite the use of lottery to ration hunting rights for Moose (*Alcesalces)* in Maine, American Black Bears (*Ursusamericanus)* in Minnesota, White-Tailed Deer (*Odocoileusvirginianus)* in Connecticut and Virginia, and Wild Turkeys (*Meleagrisgallopavo*) in New Jersey.

The main argument put forward in favour of lotteries is that they distribute rights without regard to an individual's income or status and are therefore 'eminently fair' (Hardin, 1969). Further, once established, they are relatively simple for consumers to participate in and any additional equity or equality concerns are easily addressed by, for example, giving priority to local

[8] Although not discussed here, the non-market valuation literature includes a body of work investigating the implications of lottery rationing on value estimates (Akabua et al., 1999; Boxall, 1995; Scrogin and Berrens, 2003).

residents or previously unsuccessful applicants (Kerr 1995; Shelby and Heberlein 1986).

The principle argument against the use of lotteries is similarly straightforward. By allocating rights randomly, no consideration is given to the relative values individuals place on obtaining that right. Lotteries are therefore inefficient (Kerr, 1995). Other concerns include the role of speculative applicants and no-shows, although, as is the case with advanced reservations, these issues can usually be addressed by careful lottery design.

Merit

A merit allocation mechanism distributes permits on the basis of some demonstrable skill, knowledge, personal attribute or past behavior (Stankey and Baden 1977). Although this method of allocation is relatively untried in the management of protected natural areas, it has been used in allocating tickets to sports events, where clubs often allocate tickets to away games based on club membership or attendance record at home games.

One argument in favour of this approach is the idea that rewarding meritorious behaviour is a desirable component of any allocation or rationing mechanism. It has also been argued that improved knowledge and behaviour (for example, as a result of being required to attend safety or appreciation courses to obtain entry) may reduce per-unit visitor impacts, thus allowing higher use-levels. It is also possible that the time and effort spent acquiring 'merit' status may help ensure places are allocated to those who value the resource most highly. The primary difficulties with this approach are the question of what criteria to use to determine 'merit' and the associated costs of administering such a mechanism.

ALTERNATIVE ALLOCATION MECHANISMS - THE VISITOR'S CHOICE

Visitor preference for alternative rationing or allocation mechanisms, given a rationing mechanism is to be put in place, is an area paid little attention in recreational research. Of the very few studies specifically investigating visitor preferences for alternative rationing or allocation mechanisms, McCool and Utter (1981) find strong preference for an advanced

reservation system among rafters on the Salmon River, Idaho. Taking a more comprehensive approach, Shelby *et al.* (1982) present backpackers and rafters in Oregon with five alternative mechanisms - pricing (including the use of peak-prices), advanced reservation, lottery, queuing and merit. Asked to evaluate each of these mechanisms in terms of chance of obtaining a permit, fairness, acceptability and willingness to try the system, all users indicate support for pricing and advanced reservation. Reactions to the other three mechanisms were mixed. Rafters showed relatively more support for the use of lotteries; a result the authors attribute to the fact that rafters were more familiar with the mechanism, as at the time lotteries were being used in other river systems. Backpackers generally showed more support for queuing. Reaction to the use of merit as an allocation mechanism was also varied. Rafters and backpackers agreed on the fairness and acceptability of this rationing mechanism; however rafters viewed merit as being detrimental to their ability to obtain a permit and thus were less willing to try this approach. The authors conclude that characteristics of different areas or activities affect user assessments of allocation mechanisms, and thus rationing or allocation policies should be tailored to the expected clientele.

In a similar study, Wikle (1991) presented both users and managers of four rivers in the United States with seven alternative rationing or allocation mechanisms. These were advanced reservation, queuing, zoning (whereby a recreational area is divided into sub-sites that are managed for specific types of recreation experiences), lottery, merit, priority for first time users and price. Asked to rank the mechanisms from most to least preferred, users' perceived advanced reservation to be the most acceptable mechanism, followed by queues and lottery. In contrast, managers ranked zoning as most acceptable, followed by lottery and advanced reservation. For both groups, price and priority for first time users were ranked least acceptable.

In a more recent study, Fleming and Manning (2015), for the case of visitors to Lake McKenzie, Fraser Island, Australia report that the 'economists choice' (peak pricing) is not favoured by any visitor group, even those on high incomes, and that it is clear that visitor caps and 4WD access restrictions (a form of physical constraint) are preferred to either maintaining the existing open access policy or the imposition of peak pricing; although older visitors, males and those who own 4WDs are less supportive of 4WD access restrictions than the general population.

DISCUSSION

As noted at the beginning of this chapter, as the popularity of nature-based tourism grows, so too does pressure on the natural amenities upon which the industry is based. This pressure manifests itself in overcrowding and damage to the natural environment, both of which serve to reduce the value of the experience to visitors. To address this issue, recreation researchers/managers have developed a number of management frameworks, including the recreation opportunity spectrum and limits of acceptable change. More recently, computer simulation modelling has been used to proactively manage visitor impacts.

Following the choice and implementation of a management framework, resource managers must choose a management strategy - whether to exclude all recreational visitors, allow all recreational visitors and activities, or allow certain recreational visitors and activities. The latter is a common strategy and raises the issue of choice of sub-strategy, namely whether to manage demand, manage supply, manage the resource or manage impact.

If managing demand is the preferred sub-strategy, the resource manager is then faced with a number of options. These options include managing demand via price, physical constraints, demarketing or quotas. If the latter is chosen, the issue then becomes one of selecting an appropriate allocation mechanism; with queuing, advanced reservation, lottery and merit all plausible alternatives.

LOOKING FORWARD

There remain a number of avenues for further research into visitor preferences for alternative management regimes for protected natural areas. In particular, much remains to be learnt about visitor preferences for alternative management regimes in a variety of recreational settings. Existing evidence points to significant heterogeneity across recreational sites in terms of both impacts and visitor preferences. This makes it difficult to draw definitive conclusions about the choice of management strategy or sub-strategy – this choice needs to be made on a case-by-case basis by resource managers and further research will aid decision making in this respect. Nonetheless, if managing demand is in the policy mix, it is hoped that the overview provided in this chapter serves as a useful starting point for an evidence-based policy discussion.

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Chapter 3

SHIFTING PARADIGM OF GOVERNANCE IN THE NATURAL RESOURCES MANAGEMENT OF BANGLADESH: A CENTRALIST TO PLURALISTIC APPROACH IN THE FOREST PROTECTED AREAS MANAGEMENT

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ABSTRACT

Good governance in natural resource management (NRM) is one of the most challenging issues in developing countries that often

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inappropriately embedded in national policies and political agendas. It is, in fact, even more important for countries like Bangladesh with exceptionally high pressure and dependence on its natural resources for sustaining rural livelihoods. Globally, nowadays, good governance is considered as one of the key factor for achieving the goal of sustainable development and biodiversity conservation. Bangladesh, of late has responded to that global zeal by involving local communities in the management of country's declining forest and other natural resources. The colonial legacy of the forestry sector of Bangladesh was planned and, managed as interim projects through donors' prescriptions. Thus, institutions, management processes and conservation outcomes were problematic. The conventional approach adopted by colonial and post-colonial regimes for forest management also proved to be inefficient due to its top-down management system. The absolute dependency on donor support, and their prescription sometimes worsened the situation both ecologically and socially. Global, regional and local trends supported the need for a different dimension in the governance paradigms. The introduction of a pluralistic approach, known as co-management in protected areas (PAs) is an example of an attempt whereby shared governance mechanism are implemented to attain the desired goals of conservation that will also address the livelihoods and aspirations of communities living in and around PAs of the country. However, in designing future forest and PA regimes the concern of the external aid support and attached conditions remain a reality that needs to be addressed. Adequate attention should be given to our vanishing biodiversity, culture and community livelihoods through devising an appropriate governance mechanism recognizing and supporting local rights, access and participation in the environmental management. It is now time to mainstream the *adhoc* nature of governance according to our national conservation strategy and policy frameworks in order to achieve the goals and objectives of the Bangladesh NRM sector addressing the human and community right of people in the specific context of forest protected areas management.

Keywords: co-management, livelihoods, conflicts, biodiversity conservation, sustainable development

INTRODUCTION

Sustainability and sustainable development (SD) are the most widely spoken terms in various development and management paradigms. They emerged to bridge the disconnection between development and conservation

and to embrace various attributes like governance, participation, rights and access (Rogers et al. 2008). The international community now focuses on diverse concepts, strategies and processes to address SD. One of the growing concerns is biodiversity conservation that involves sustainable livelihoods, good governance and active community participation (Rashid et al. 2007).

Management of protected areas (PAs) is an evolving trend that also embraces active community participation as an essential element of governance hence pluralistic approach like co-management is getting amid attention globally (Rashid et al. 2013a, 2013b). Bangladesh is also responding to that evolving trend in its natural resource management (NRM) sector especially in forest PAs). However, the features of governance are still a limiting factor that demands careful consideration of the ecological, social and institutional attributes influencing various stakeholders particularly the community living in and around the PAs.

The rapid destruction of the biological resources in developing countries due to socio-economic and political drivers[1] brings the importance of PA conservation and management into limelight. With the growing global concern of sustainable use of forest resources to check rapid biodiversity loss and threatened ecosystem, each country has adopted some forms of legal framework to deal the issues of PA declaration and governance. As PAs are central for conservation oriented initiatives addressing SD, it requires better understanding of the global concepts and local context (Orlovic-Lovren 2011). According to World Commission on Protected Areas (WCPA) protected area is:

> An area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of associated cultural and natural resources, and managed through legal and other effective means.

Recently IUCN redefined the definition (based on the definition given in 1994) of PA through its World Conservation Congress (Dudley 2008) as:

> A clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values.

[1] Poverty, over population, resource scarcity and over exploitation of natural resources is the common drivers.

Establishment of PAs has emerged as a key conservation strategy in the backdrop of rapid deforestation and biodiversity losses worldwide (DeFries et al. 2007; Ormsby and Kaplin 2005). Over the last few decades, the number and coverage of PAs has increased significantly in most parts of the world (Kaimowitz and Sheil 2007; McNeely and Scherr 2003), and currently there are more than 100,000 PAs globally, covering around 12% of the land surface (Scherr et al. 2004; Chape et al. 2003). Such development has also taken place in many developing countries in the tropics where biodiversity is rich and local communities are heavily relying on forest for sustaining their livelihoods (Koziell and Saunders 2001; Ghimire 1994). However, in many instances establishment of PAs has failed to achieve the desired conservation goals due to pure ecological focus and poor recognition of local and indigenous people's traditional forest rights and practices (Ormsby and Kaplin 2005; Craig 2002; Nepal and Weber 1995). Such exclusion has also led to conflicts and mistrust between PA managers and local forest user communities hence management and conservation goals of PAs were significantly obstructed (Borrini-Feyerbend 2002).

Local people's support and involvement for PA management has been viewed as an important element of enhanced conservation in recent years, especially in developing countries (Wells and McShane 2004; Nagothu 2003). This new approach of PA governance commonly known as co-management or collaborative management is a major emerging issue for conservation policy in many developing regions that has also been widely recognised and promoted by various international conservation agencies as a means of governance (Fisher 2003; Jeanrenaud 2002; Kothari et al. 2000). This strategy enables active participation of local community in PA management and most often offers them some direct and indirect benefits that help in sustaining their livelihoods apart from achieving conservation goals (Nagothu 2003).

AIM AND SCOPE OF THIS CHAPTER

Bangladesh, as one of the most densely populated countries in the world, had significant forest cover until the British colonial period, with about 20% forest cover, and even until 1980 was a home to about half the bird species and a quarter of all mammal species of South Asia (Poffenberger 2000). Various state interventions in support of conservation can be traced back to British Colonial period but very few of the conservation goals were met and the depletion of the forest and biological resources continued at an alarming pace

resulting in the further shrinkage of the actual forest cover (FAO 2009). Various interim efforts were taken in the name of community forestry; social forestry that have brought about visible success in increasing physical coverage but failed to create a synergy between conservation and development goals due to the absence of active community participation in overall decision-making process (Alam 2009). Such disparities affected the overall governance mechanisms of the PAs in the country (see Rashid et al. 2013a, 2013b; Mukul et al. 2012; Mukul and Quazi 2009).

Under this backdrop, the Government of Bangladesh has started establishing PAs and initiated co-management to address the biodiversity conservation and livelihood of the forest dependent community (Chowdhury et al. 2009). Till today, the government has declared 38 PAs (according to IUCN PA Management Categories they belong to category II, IV and VI). Of them 20 PA's have so far been taken under the umbrella of shared governance widely dubbed as co-management (BFD 2016), that covers less than 2% of the total land area of Bangladesh (Mukul et al. 2008). These figures are amongst the lowest in the world (WRI 2007), despite the country's exceptionally rich biodiversity favoured by its' unique geo-climatic conditions (Appanah and Ratnam 1992). Furthermore, a large portion of the rural poor are either forest dwellers or forest dependent for their subsistence (Roy and DeCosse 2006). Introduction of co-management is the mere attempt to address both ecological and socio-economic attributes.

The concept of co-management and its application in the PAs of Bangladesh is quite new. To promote the issues of conservation and sustainable local development through a shared governance system Bangladesh Forest Department (BFD) has developed a program of forest co-management in five PAs in 2002 on pilot basis through an initiative called Nishorgo Support Project (NSP), with active support from USAID. This pilot project is further scaled up in the name of 'Integrated Protected Area Co-management' (IPAC) with broader magnitude covering wetlands along with the forest PAs (Rashid et al. 2013a). During the NSP period, five PAs (Lawachara National Park, Satchari National Park, Rema-Kalenga Wildlife Sanctuary, Chunati Wildlife Sanctuary and Teknaf Game Reserve) were considered as pilot sites to apply the concept of co-management. These sites are unique from the perspectives of biodiversity richness as well as for the high level of exploitation. The aim of this chapter is to share the experiences of different 'co-management' initiatives from two of these pilot sites and their effectiveness and acceptance to local communities, and finally put some recommendation based on the flaws of these initial initiatives.

This chapter is based on the outcomes of the empirical studies carried out in Chunati Wildlife Sanctuary and Lawachara National Park. Existing legal and policy frameworks developed by the international community that recognised and accepted governance as an integral element of achieving SD in NRM sector especially in PA management have also been considered while analysing the facts related to PA governance. The introductory section highlighted the concepts and salient features of governance and their relevancy to biodiversity conservation while the second section described the history and evolving trend of community oriented forest management in order to depict the existing scenario of governance in PAs. The role of local institution and active engagement of local community have also been examined through the case studies. The final part of the chapter concluded with suggestions for future improvement of the PA governance in the country.

PROTECTED AREAS: CLASSICAL VS POPULIST APPROACH

In the past PAs were established keeping the local communities and forest dependent people on the periphery by imposing restriction on access and rights over resources. The majority of the parks established before 1980's followed exclusionary state-run approaches, restricting customary usufruct rights of the local community (Mehta and Heinen 2001). One of the vivid examples of such type is the Kruger National Park in South Africa. Here, the local community was forced to leave the area where they had been living for generations (Fabricius et al. 2001). This conventional approach of PA management was largely been ineffective as it further worsened the situation through rapid destruction of biodiversity and natural resource base. Such exclusionary approach is also against the notion of sustainable development and human rights.

With the repeated occurrence of park-people conflict due to the restriction and replacement, there has been a growing concern and understanding among the international community that, such exclusion will further deteriorate the ecosystem and livelihood base of the local community. Wide scale adoption of shared governance with decentralized decision-making process is an attempt to address these tensions (Ferrari 2006). Various legal and policy interventions were devised that recognised local community and other major stakeholders as an integral part of the PA management. Active engagement and in many cases

a decision making role with the advent of *Populist Approach*[2], the concept of PA management has expanded from biodiversity conservation to human welfare and livelihood perspectives (Naughton-Treves et al. 2005). This approach to management has increasingly been contested in both developed and developing country context as the centralist approach of PA management proved inappropriate due to its management process and governance mechanism (McNeely et al. 2006).

GOVERNANCE FOR SUSTAINABLE DEVELOPMENT AND BIODIVERSITY CONSERVATION: CONCEPTUAL ATTRIBUTES

The concept of sustainability integrates social and economic dimensions as essential aspects of ecosystem conservation emphasizing poverty alleviation, community participation, social justice and equity (Craig 2006). Economic, environmental and social aspects of SD require sustainable livelihood support, improved environmental protection through the integration of modern science and widespread public participation and local governance. Apart from these, strong local institutions, capacity building and long term financial support from development partners in developing nations are also a prerequisite in achieving sustainability (Dubois and Lowore 2000). International legal and policy frameworks are also playing a crucial role in guiding and determining the role of governance in the NRM sector in general and PAs in specific. From Brundtland report to Agenda 21 (i.e., Forest Principles) and Convention on Biological Diversity (CBD) all reiterated the importance of SD as a preamble of all conservation and development initiatives.

Generally, governance deals with the formation of rules and decision-making procedures and helps operating social institutions based on these regulations. The term governance differs from the aspect of management. Governance addresses the attributes of decision-making processes and identifies the stakeholders behind making these decisions while management addresses the outcome of any decision (Bosselmann et al. 2008). Governance denotes the structure and process used by different social actors to formulate

[2] It is a political idea and activities that are intended to represent ordinary people's needs and wishes instead of excluding them from any forms of participation or decision-making process (oxford dictionary).

and influence the decisions on matters of community concern (Abrams et al. 2003). Fundamentally, governance is about power, relationships and accountability.

The context of governance varies significantly ranging from global, national and local setting to social and institutional setting (Carter et al. 2009). As more and more instances of decentralization and devolution of power are taking place in line with the international policy and legal principles, which are framed to achieve SD, the importance of governance has got momentum in the field of NRM. The concept of governance provides directives that need to look beyond the government towards a public-private-civil society partnership in order to overcome the limitations of the long practiced traditional top-down approaches (Berkes 2003). The introduction of co-management in the PAs management is such an attempt whereby community stakeholders are granted with user rights and operational responsibilities. With this development in practice, the term governance also takes various forms like good governance, environmental governance and protected area governance those needs be discussed for better understanding of these evolving trends.

Environmental Governance

Community participation, accountability, transparency and pro-poor policy changes are considered as crucial dimension of natural resource governance (Dahal 2003). With the growing concern of governance as a new mechanism, community people have started gaining their legitimate voice in the SD process. Furthermore, international policy instruments have developed best practice principles to enhance good governance in various sectors. With the adoption of action plan of the *Rio Declaration* through the *Agenda 21* and the CBD principles, the scope of governance has clearly extended into the environmental conservation and sustainable use of biological resources. However, it is worthwhile to mention that conservation alone cannot solve poverty but can significantly help to prevent and reduce it through maintaining ecosystem services and supporting livelihoods (Naughton-Treves et al. 2005).

Co-management in PAs governance needs global policy and legal directions in order to mainstream it into national laws in most developing nations. Articles 8 and 10 of the CBD have immense significance, highlighting the importance of in-situ conservation, the recognition of indigenous people's rights and their traditional knowledge, and the importance of public-private partnerships.

Protected Area Governance

Governance is not only a key concept in the field of biodiversity conservation but also emerging as a significant concept in PA management (Balloffet and Marin 2007). In a PA context, governance has got various dimensions ranging from policy to practice, attitude to meaning and from investment to impact that can influence the management objectives of the PAs (Lockwood 2010). PA governance concerns the structures, processes and traditions that determine how this power and responsibilities are exercised. It is exercised over a broad spectrum of management and must be backed by proper legal and policy framework to address multi-faceted goals and priorities (Jeffery 2004). The conventional top-down approach of governance has already been augmented and replaced by the people centred management regime under different forms (Borrini-Feyerabend 2003). Borrini-Feyerabend et al. (2006) clarify PA governance by isolating it from management as:

> Management is about what is done about a particular site or situation, governance addresses decisions, who makes these decisions and how.

A good number of international and regional initiatives have helped to shape a new direction for conservation governance applicable for PAs. The importance of governance as key factor in PA effectiveness came to light during the 5th World Parks Congress (held in Durban 2003) of IUCN (Dearden et al. 2005) The CBD Programme of Work (PoW) on PA adopted in 2004 at the 7th Conference of the Parties (COP) also generated new commitments and policy guidance for the global PAs (SCBD 2008) The Durban Congress also developed a set of 'good governance' principles based on the general attributes of the good governance principles and includes legitimacy and voice; subsidiarity; fairness and performance and accountability as basic components (Borrini-Feyerabend et al. 2004). As the principle of governance and its performance vastly depends on the nature of community participation, the following sections attempt to explore the basic attributes of community participation particularly in context of PA management in Bangladesh.

DEVELOPMENT OF PARTICIPATORY FOREST MANAGEMENT REGIME IN BANGLADESH

There is a growing recognition and consensus among the policy makers that, traditional forestry practices need to be replaced by a more sustainable option of management (Muhammed et al. 2008; Ali et al. 2006). Participatory forestry in Bangladesh draws amid attention in this regard as a strategy both for resource management and community development (Khan 1998). Encompassing greater control over forest resources has created ample opportunities for participatory forestry and the possibilities to improve the livelihood of the local forest dependent people (Cronkleton et al. 2010). However, community participation is a difficult task in any society and situation which is more critical in developing country context like Bangladesh due to the socio-economic inequalities and absence of good governance (Khan et al. 2004). The trend of the participatory forest and PA management and their role in enhancing governance as an imperative to SD have been discussed in the following section.

Community Participation in Forestry Sector: Existing and Evolving Trends

Community participation in the forestry sector of Bangladesh is a recent development drawing momentum in the face of global recognition (Khan 2009). The FMP described and highlighted the participation as a new mission and challenge to develop the forestry sector in order to overcome the colonial legacy characterised by bureaucratic and revenue oriented management, widespread isolation from community by ignoring their traditional rights, indigenous knowledge and resource use practices (Khan 2009). The participatory concepts of forestry dealing and engaging local people as participants officially coined through community forestry projects that further expanded and replicated through various projects such as TANDP, FSP, CGP and Sundarbans Biodiversity Project (Muhammed et al. 2005). Although these projects made significant provision for community involvement in the name of participants, the nature and extent of participation varied significantly that is also influenced by the governance mechanism (Chowdhury 2005). The following discussion attempts to highlight the salient features of the various projects in relation to participation and governance.

Community Forestry Project

This is a pioneer attempt of the Bangladesh Forest Department (BFD) with an objective of benefiting rural poor by producing fuel wood for domestic uses, fruits, construction timber, and fodder and to mobilise community towards tree plantation. It spanned from 1981-1988. Institutional capacity building of the BFD was also among the other agendas with a view to expanding social forestry throughout the country. The project was implemented in seven North-western districts of Bangladesh with the financial assistance of Asian Development Bank (ADB) as loan grant (Khan et al. 2004). Patches of Sal forest[3] and marginal lands were brought under the project jurisdiction.

The project sets various physical targets such as establishment of strip plantation, wood lot plantation, agro-forestry, training and institutional support. Although it succeeded to achieve majority of the physical targets but the development in terms of social goals were very limited (Khan et al. 2004). Farmers were indifferent to the seedlings provided by the authority as their choices of species were not reflected during plantation stage. The extension service was even inadequate at farmers' level. The major limitation of the project in terms of community engagement was that, it failed to come up with a written and formal agreement of the specific rights to benefit over the resources upon maturity hence failed to draw mass attention of the local community. Despite creating a good number of short term employment opportunities in nurseries and plantations the governance issue was still fully ignored or absent.

Thana Afforestation and Nursery Development Project

Thana Afforestation and Nursery Development Program (TANDP) was a follow-up project of the Community Forestry Project also supported by ADB loan. The project spanned over a period of 1989-1996. It also aimed at increasing the production of biomass fuel, enhancing institutional capacity of BFD to enable them in implementing a self-sustaining SF programme. TANDP managed to fulfil its physical target like the previous project. However, this project significantly varies from the previous one in terms of operational area since it covered almost whole Bangladesh (61 out of 64

[3] One of the major forest types of Bangladesh characterized by dry and deciduous tree species.

districts of Bangladesh). Forest lands were mainly brought under the project (Khan et al. 2004). The level and content of community participation varied significantly. The community participation was mainly for the protection of the planted trees in strip or in block plantation. Absence of the scopes of harnessing immediate benefits and the land tenural insecurity adversely influenced the notion of participation. This is also influenced by the patronage relation between poor farmer and local elites (Das 2008). The institutional capacity building of the BFD was also experienced several complexities since a large section of the project staffs were recruited on temporary basis that significantly influenced the overall governance of the project.

Forestry Sector Project

Forestry Sector Project widely known as FSP was another development support in forestry sector by ADB implemented during the period of 1996-2004. It was the largest public sector intervention on social forestry (SF) in Bangladesh. The designated aims of the project included conservation of forest in selected PAs, increase wood production, institutionalization of forest resource management through community participation, institutional capacity building and policy reform. According to ADB Mission Report, the project was a successful one although some of the components like protection of the natural forest through community participation failed to achieve the target (Khan et al. 2004).

A significant achievement took place during the project tenure in terms of institutional and policy reforms. The Forest Act, 1927 was amended in the year 2000 and broad stakeholder consultation took place to finalise draft rules and regulations to provide a legal shape to SF. However, the Indigenous and ethnic minority groups questioned the process of consultation. The positive side of the project is that, it involved a considerable number of local development organizations as partners in the implementing process. The project succeeded in increasing the green coverage of the country through partnership initiative (public-private-NGOs) but the issues of governance still remain unattended.

Sundarbans Biodiversity Project

The Sundarbans Biodiversity Project widely known as SBCP was also an initiative through ADB loan support implemented with a view to ensuring sustainable management and conservation of the biodiversity of Sundarbans Reserve Forest. The project aimed at the reduction of poverty of 3.5 million people living in and around the impact zone of Sundarbans by adopting the following participatory approaches for social development in the impact zone:

- Assessment of base line data to determine socio-economic condition;
- Organizing and mobilising the resource users;
- Creation of alternative source of micro-credit support to the community-based groups to create alternative employment opportunities;
- Social infrastructure development.

Although the project designed to implement various components related to participatory management of the Sundarban Reserve Forest but due to the lack of significant progress in community and stakeholder engagement, the project was suspended. Ineffective governance and poor financial management was the major reason behind this suspension. The donor advised BFD to re-formulate the project proposal through active community participation and consultation with various stakeholders as precondition to revive the project.

Coastal Greenbelt Project

This ADB supported project was specially designed for the coastal districts of Bangladesh with a view to improving the coastal environment by tree plantation and to fight poverty through creating alternative income generation opportunities. The project managed to raise 8934 km of strip plantation whereby 143936 participants and more than 100 NGOs were directly involved with the project implementation. As per the review report the physical achievement was satisfactory (Millat-e-Mustafa 2002).

It also generated employment and the frequency of women participation in the project was higher compared to other programmes (Millat-e-Mustafa 2002). However, land use and tenural rights remain big issues that significantly influence the notion of active community participation. Public

engagement and the process of NGO engagement were criticised by the participants due to the bureaucratic nature of the BFD.

SOCIO-ECONOMIC AND GOVERNANCE ATTRIBUTES OF THE PARTICIPATORY FORESTRY PROGRAMME

Participatory forestry officially coined in the name of CF, SF in Bangladesh. Although they made various provisions of participation in the project proposal but the active engagement of community in the decision-making process was obscure. The following discussion examined and summarised the socio-economic and governance attributes based on several evaluation study.

Socio-Economic Attributes

Various socio-economic attrbutes have directly or indirectly ifleuned the participatory approach of forestry practices popularly known as social forestry. Some of the major findings can be summarized as follows:

- Participants' selection was a crucial factor which in many instances was influenced by patronage relation. A significant portion of participants was drawn from large land owners, local influential and elected representatives of the local government bodies. Such inclusion of elite members forced to obscure the voice of the grassroots people in management and governance.
- Womens' participation in planning and decision-making process was marginal. However, their involvement in protection and maintenance of the plantation was significant.
- Participants received a good amount of money as share of the harvested products. They invested the received amount for various purposes such as debt repayment, purchasing of farming animals, buying land and in small business.
- Participants received training on plantation technique and management both by FD and NGOs. Community organising and mobilising strategy training was provided to FD officials as well as to

the participants that helped increasing awareness regarding participatory forestry approaches.

- Participatory forestry in the name of CF, SF enabled participants to be more respectable within community. Their economic solvency helped to uplift their status and recognition in the society. However, access to better health, education and sanitation still remain as a far reaching goal.

Governance

Passive community participation was experienced. Participants were not actively involved in the planning, monitoring and group formation process. BFD or nominated NGOs were mainly engaged in accomplishing all these activities. However, in some project areas FD informed the participants about the project and the potential benefits of involvement as participants in the project.

- The species choice for plantation was even decided and directed by the BFD and accordingly arrangements were made that significantly influenced the participation process as participants were confused about the future existence of the programme (assumed it as an another adhoc intervention.
- BFD was all in all in taking and implementing the decisions. Formal procedures were maintained just by informing and receiving approval from the *Upazilla* and *District*[4] Coordination Committees related to forestry.
- In some project location participants expressed a sense of ownership which is manifested by regular contacts with BFD people, regular vigilance of plantation site and presence in meeting
- The coordination among various stakeholders was not satisfactory. Top-down management approach was still dominating in the process in the name of participatory forestry.

[4] Local administrative units under the jurisdiction of the division. There are 64 districts in Bangladesh. Each of them again divided into several sub-districts called Upazilla.

CO-MANAGEMENT AS A TOOL OF PROTECTED AREA GOVERNANCE IN BANGLADESH

The major weakness of forest management in Bangladesh is the incapability to ensure participation of the forest dependent community (Nath and Inoue 2010). Participation in governance and the necessary legal and policy frameworks was weak as noticed in many forestry projects of Bangladesh. Although most of the participatory forestry projects have managed to achieve physical targets but meeting social targets of community participation and equitable distribution of share and rights were still lacking (Nath and Inoue 2010). The top-down approach was still persisting that ignored the rich history of traditional practice and knowledge base. Recognising the weakness of the conventional forest management and the continued depletion and degradation of the forest resources, the government started establishing PAs since 1980s and gradually adopted legal frameworks for community participation in governance through co-management approach (Rashid et al. 2013b). However, the declaration of these PAs adds little to the conservation and management of depleting biodiversity because of the predominant classical approach to management with an ecological focus that often excludes local rights and practices (Mukul et al. 2010; Mukul and Quazi 2009).

The co-management concept was first adopted for the aquatic resource management in the name of MACH (Management of Aquatic Ecosystems through Community Husbandry) during 1998 on pilot basis with a view to addressing poverty and ensuring sustainable management of wetland and aquatic resources through engaging local community in decision-making process (Quazi et al. 2008). Based on the relative success of this project, the government of Bangladesh with the active support of USAID took a similar pilot project for the management of the PAs in the name of Nishorgo Support Project (Biswas and Chowdhury 2011). In Bangladesh the PAs quite often overlap with the forest area since most of the PAs are the forest PAs[5]. These PAs represent three major forest types of Bangladesh namely Hill forest, Sal Forest and Mangrove Forest and belongs to the IUCN Guidelines of PA Management Categories II and IV (Dudley 2008). After the completion of NSP, the forest department undertook new initiative under the financial

[5] A subset of all protected areas that includes a substantial amount of forest. This may be the whole or part of a protected area managed for biodiversity conservation and associated cultural values.

assistance of USAID to scale up the co-managemnet in other PAs under the project titled Integrated Protected Area Co-management (IPAC) that continues from 2008-2013. Governance attributes were given priority in the second phase of co- management program. Based on the relative success of the IPAC, another project intervention was devised in the year 2013 titled Climate Resileint Ecosystem and Enhanced Livelihoods (CREL) that has also included wetlands in addition to forest PAs.

The Nishorgo Protected Area co-Management Initiatives

Nishorgo Support Programe was based on the normative framework of conserving vanishing forest biodiversity and ensuring livelihood support for the local community dependent on PAs (Khan 2008). NSP selected 5 PAs as pilot sites in order to develop a model that further replicated gradually to the other PAs of the country (Quazi et al. 2008). As a consequence of this development co-managemnet approach has sacled up to 18 Pas till todate. The main focus of the co-management approach under NSP includes protection and conservation of all natural forest and its biodiversity, conversion of monoculture of exotic tree species with indigenous species, development of co-management agreements with key stakeholders and capacity building of the BFD for better administrative, management and policy support for the PAs (Sharma et al. 2008).

Most of the PAs of Bangladesh are part of some reserved forest (RF) and are subject to massive exploitation by neighbouring people for subsistence and income for years. One of the key challenges for Nishorgo in these PAs was therefore, to provide people with alternative income generating (AIG) options to divert their dependency on forests and forest products. However, as the effort was limited by resources, it was obviously impossible to bring the entire forest dependent community under the umbrella of AIG. To promote participation in park management and decision making process *Nishorgo* formed some legal institutions in the name of Co-management Councils and Co-management Committee (CMC) in each of the pilot sites taking representatives from all stakeholder groups including representatives from government. There were regular monthly meetings in these sites where members of the committee were informed any progress or initiatives taken in their respective PA and had chance to share their views, needs and/or any recommendations for better management of the park.

Based on the relative success of the NSP, the concept was further expanded in other protected areas with the intervention of new projects named Integrated Protected Area Co-management (IPAC) and Climate Resilient Ecosystem and Livelihood (CREL) addressing various dimensions of collaborative PA governance.

GOVERNANCE AND INSTITUTIONAL ATTRIBUTES: EXPERIENCES FROM THE EMPIRICAL STUDIES

Empirical studies were conducted in two of the pioneer PAs namely Chunati Wildlife Sanctuary and Lawachara National Park. Focused Group Discussion (FGD), semi-structured interview, key informant interview and personal observation were the major tools used to obtain required information. Monthly meeting of the co-management committee (CMCs) were attended apart from visiting their official documents. Secondary data and informations were also referred to ascertain the governance and institutional aspects of the PAs.

Chunati Wildlife Sanctuary

Chunati Wildlife Sanctuary (CWS) is particularly important as it is the habitat and an important corridor for Asian elephants. Furthermore, a significant number of local people are directly or indirectly dependent on this sanctuary for their livelihood. CWS is part of the southern cluster of IPAC managed PA where co-management is in practice from NSP period. The field work conducted during the period of July, 2010 - January, 2011 reveals that institutional and legal framework in support of the co-management approach significantly influence the governance issue. Currently two CMC are in operation in CWS (one in Chunati range and the other in Jaldi range). Based on the physical visits, follow up of the monthly meeting of CMC, FGD and in-depth interview with the various stakeholders; it revealed that CMCs are embraced with following challenges:

- The CMCs are still dominated by the elite peoples. No significant voice of the community people is noticed, although the number of members in CMC have been increased through legal notification to

ensure more representation of the vulnerable group (i.e., FUG, CPG, ethnic minority, woman etc.);

- Trust and performance is the key to governance which was missing in the study area. Local forest officials in general do not own the concept of co-management. Monthly meetings are still arranged and initiated by the IPAC staffs whereas being a Member Secretary; it is the responsibility of the respective Range Officer to take all initiatives regarding arrangement of the monthly meeting;
- Encroachment is a critical issue in CWS. One third of the area has already been encroached and turned to o agricultural land. Such uncertainities influenced forest dependent people to resratin from participarting in the co-management initiatives. Local forest department also has failed to create their image that can satisfy community with assurance;
- Political manipulation t is a growing concern in any NRM project like co-management in PAs. Development partners hardly allocate any budget for that, which is adversely affecting the overall governance;
- Legal atrubutes like acts, rules, policies etc. are not clearly and widely shared to the community. Such limitation is creating confusion and conflicting situation between BFD and community. With the promulgation of SF Rules of 2010 (amended), a vast forest area further goes under the control of local political elites in the name of public-private partnership as optioned in the amendment;
- Ambiguity of both BFD and CMC regarding transparency and accountability is further deteriorating the situation;
- Sustainability of CMC is a critical issue since there is no provision of resource support either internally or externally. Due to the absence of self funding sources the CMCs can not undertake any development projects on their own;
- As a shared governance approach, both BFD and the committee members needs to participate actively to develop plans and programs for the sustainable management of the respective PAs and livelihood aspect of the forest dependent community. However, BFD representative was found reluctant in arranging monthly meetings and determining agends pertinent for the PA and its development;

Table 1. Legal, policy and institutional attributes affecting PA governance in Bangladesh

Issues affecting PA governance (when CMC is an institution)	Key findings				
	Legal and policy issues	*BFDs role in implementing co-management*	*Community participation*	*Co-management as an governance option*	*NGOs role*
Dominated by elite members	Supportive but problem with implementation	Still dominated by command and control management	Passive engagement like SF,CF	Good platform to enhance accountability, responsibility, legitimacy and voice of multi-stakeholders	Better acceptance by the development partners
	Needs to formulate rules and procedures related to joint or collaborative management	Not conducive for SD	Decision-making process still dominated by BFD and elite members. Members representing vulnerable and grass root community remain inactive.	Concept needs to be location and individual need based under the notion of *Common but differentiated responsibility*	Strong footing for community mobilization
Enhanced connection between BFD and community	Adhoc nature of the projects affecting the proper implementation	Co-management is yet to be accepted at every level	Benefit driven participation	Lacking with orientation at community level. People still perceive PAs as a recreational place	Absence of skilled manpower particularly technical staffs
Absence of long term vision and strategic planning	Forest offenses are not addressed immediately	Concentrating more on achieving physical targets (i.e., increase in plantation coverage)	Excessive operational expenses affecting AIG activities	Creates scopes for shifting the governance paradigm	The contracting nature and scope of work needs re-consideration for better performance
Poorly funded hence affecting sustainability and better community engagement	Political influence is a big challenge at field level	Failed to materialize the integration of livelihood for PA management		Needs resource and technical support to mainstream the concept	
Completely dependent on project support(i.e., physical, technical, financial assistance)					

- Political governance is also significantly affecting the notion and zeal of the participation. In one of the study area CMC meeting was suspended consecutively for 3 months as the chairman was unable to present. He was even reluctant in giving consent to arrange the meeting headed by the vice-chairman of the CMC;
- Accountability, transparency, legitimacy and voice are the preconditions for ensuring good governance. Adhoc nature of the projects in NRM sector is one of the impediments to achieve desired goals.

Various stakeholders were interviewed to ascertain the multiple aspects related to PA management. Table 1 present glimpses of the salient features raised by the respondents from different quarters having stakes in the implementation of the co-management approach in the PAs of Bangladesh.

Lawachara National Park

Lawachara is famous for its' rich faunal diversity, particularly for one of the largest population of critically endangered *Hollock gibbons* in south-east Asia. The park is also inhabited by several indigenous communities including *Khasia* and *Tripura*, who have been enjoying the usufruct right to use a limited forest area within the park for their traditional betel vine (*Piper betel*) and lemon (*Citrus limon*) cultivation. One of the *Nishorgo* initiatives in the park was, recruiting former illegal loggers as, Community Petrol Group (CPG) members to protect poaching of valuable timber from the park area. All the participants were paid lump sum remuneration and basic gears for their protection service, and the effort brought a noticeable change in the area whereby significant reduction was experienced in illegal forest activities (Mukul et al. 2014). Furthermore, such effort also adds a vibrant impact on enriching floral and faunal biodiversity. However, the enthusiasm and the efforts have started fading with time due to several reasons i.e., absence of monitoring by CMC, lack of support from the project and reluctance of the field staffs belonging to the BFD. Such limitations in co-management concept are adversely affecting the governance mechanism. Figure 1 below shows the illegal logging (in terms of no. of trees felled illegally) in Lawachara National Park (blue line) with other *Nishorgo* pilot sites between four different periods. It is clear from the graph that, the number of trees illegally felled during 2003-

04 period was about 1,200, being the highest amongst the pilot sites, which fell down to about 400 during 2006-07 period (Mazumder et al. 2007).

Another interesting observation from this pilot site was that, involving local people in forest PA conservation with clearly defined tenural rights could significantly boost-up conservation effort provided their life and living are in harmony with the forest (Mukul et al. 2014).

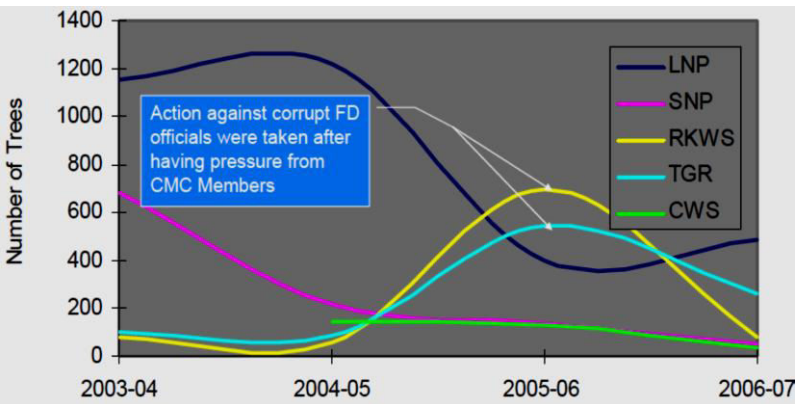

Figure 1. Illegal tree felling at different Nishrogo pilot sites.
(Source: Mazumder et al. 2007)

CLUES FOR FUTURE DEVELOPMENT

Based on the outcomes of the empirical studies as well as from opinion of the various stakeholders, it is quite evident that, co-management activities in PA sites has brought slow but explicit changes whereby decentralized, site specific and community based activities are gradually taking the place of centralized classical approach to some extent. Households who were previously plunderers are now active forest protectors. Now communities are more aware regarding conservation attributes which needs further and long term nourishment to bring positive changes. To ensure long term sustainability in conservation and better forest governance, it is very essential to focus on generous socio-economic upliftment of the communities living on forests, and ensure equity in benefit sharing. Attitudinal changes of the forest department and its officials towards the shifting paradigm of PA management are crucial in this regard. To avoid conflict, and promote traditional livelihoods of the communities, there is also the need to allow people harvesting certain amount

of forest products ensuring ecological sustainability (Mukul et al. 2016, 2010). Financial and technical sustainability of the CMC's must be ensured through innovative mechanism (i.e., continuous training for capacity building, provision of direct grants to CMC; linking with external and internal funding agencies, funding through international negotiable instruments viz. REDD+) followed by constant supervision and monitoring. Finally, legal and policy support to adore the concept is important since it is the precondition to bring better governance in management. Above all, the foremost important thing is to keep the process free from politicization.

Adhoc nature of the projects is one of the limiting factors as we have seen in various participatory forestry projects. Such short term nature programmes are also weakening the institutional and individual capacity building process. In order to overcome these barriers we need to mainstream the project through sourcing internal fund i.e., revenue budget. Continuation of the programme will not only increase the accountability and transparency but will also help to build confidence among the participants to be involved in the process. Institutional capacity building both for the BFD and CMC is crucial. Training, logistic support, financial incentives and strict monitoring and evaluation process can ensure better governance to harvest better management outcome.

Development organizations are playing significant role for community mobilization and efficient utilization of the resources needed for the project management. Furthermore, credibility of the NGOs is more to development partners for their better monetary management. However, they cannot be the replacement of the state institutions such as BFD who has the mandate, legitimacy and nationwide technical strength and physical coverage to disseminate various concepts and attributes of NRM especially in the PA sector. Thus developing a credible public-private partnership can be a desired option. Good governance in PA management through active community and stakeholder participation may add significantly to the journey of sustainable natural resource governance.

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Chapter 4

CONSERVATION WITHOUT PARTICIPATION: DETRIMENTAL EFFECT OF ESCAPING PEOPLE'S PARTICIPATION IN PROTECTED AREA MANAGEMENT IN NEPAL

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ABSTRACT

Nepal has undergone several policy reforms over the years to address multi-dimensional global conservation goals. However, such reforms, in most cases, seems disregarded the participation of local people; leading to the conflicting situation between the state and the people. Relocation program, one of the government policy implemented to enhance levels of nature protection, carried out involuntarily, has often been accompanied by poverty, deprivation, and dissatisfaction among local people. Based on the desk review of conservation policies and field study from in and around Shuklaphanta Wildlife Reserve (SWR), we analyzed the effect on the local people due to changes in policies for managing protected areas (PA) over the years. The results showed that the involuntary displacement

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of households from PA especially indigenous communities resulted negative social impact including restriction on people's customary rights to access natural resources and direct impact on livelihoods. This chapter suggests that such policy reforms and integrated management should be done with proper participation of people being affected, therefore, to insure sustainability of the policy implementation.

Keywords: people's participation, displacement, conservation, conflict, protected area

INTRODUCTION

Protected Areas (hereafter referred as PAs) are major area for biodiversity conservation and have specific biological, cultural, spiritual, economical and aesthetic values (Dudley and Phillips 2006). These pristine sites, often located in the remote areas, serve as safety nets for Indigenous and other people for various purposes (fuelwood for energy, fodder and grazing area for livestock, wild foods, thatch grass, non timber forest products etc.) (Lepetu et al. 2009). However, these PAs are managed with limited or no participation of local people and the relationship between PAs and local people are often conflicting (Andrade and Rhodes 2012; Wapalila 2008). The local people, using resources for generations sustainably are often viewed as a culprits (Andrade and Rhodes 2012). For nature conservation, local people are forbidden from using natural resources, and are displaced away from PAs, which badly affect their livelihood (Agrawal and Redford 2009).

Involuntary displacement is common in many countries which is generally imposed to establish or extend PAs, in the name of biodiversity conservation (Olivier and Goudineau 2004). The social impact of PAs is documented by many authors throughout the world (Lam and Paul 2013; West et al. 2006; Paudel 2006). Such displacement have major social impacts on local community, principally indigenous people (West and Brechin 1991). It is difficult to get the figure of displaced houses across the globe as it is not properly documented (Adams and Hutton 2007). Though the exact number of population relocated are often questioned, the available evidence pointed to the seriousness of population displacement issue during PA establishment and extension which can lead to interconnected problems (Agrawal and Redford 2009). Thus, the long term management of PA needs to involve concerns of

local people which can balance conservation and sustainable development (Struhsaker et al. 2005).

Although community based approaches in PA management have increasingly been implemented in many areas (Bajracharya et al. 2007) and got significant success in terms of conservation goals and community development, still there are some PAs in Nepal that are managed through top down approach without involving local people in governance process. The approach, though successful to protect wildlife and its habitat, was in the expense of property and life of the people living nearby the PAs (Lam and Paul 2013; West et al. 2006).

PROTECTED AREAS AND LOCAL PEOPLE: THE CONTEXT OF NEPAL

Nepal has been in the global forefront for nature conservation and has its commitments towards global conservation agendas. Of 118 ecosystem of Nepal, 80 are being protected under the intensive management of 20 PAs that includes 10 National Parks, 3 Wildlife Reserves, 6 Conservation Areas and 1 Hunting Reserve located over three geographic region i.e., Mountain, Hills and Terai (DNPWC 2016). Except conservation areas, all the 17 protected areas management are regulated by Department of National Parks and Wildlife Conservation (hereafter referred as DNPWC) in collaboration with Nepal Army, where people are not involved in the management decisions (DNPWC 2015). In Terai only, there are 6 protected areas including three national parks and three wildlife reserves covering an area of 3567 km^2 that is about 14 percent of total area of Terai in Nepal. The Shuklaphanta Wildlife Reserve (hereafter referred as SWR), our study area, is one of such PAs where the state controlled management is operational.

The notion behind establishment of the SWR was derived from conservation; where development agendas are considered, only, if they are compatible with conservation goals. Authors have argued that PAs except conservation areas in Nepal were mostly managed with little consultation with local people (Ghimire 1994; Mishra 1984). Settlements inside the core areas were displaced elsewhere, for example, Padampur village in Chitwan National Park (CNP) (Dhakal et al. 2006) and many villages including our study area Dhakka in SWR (Lam and Paul 2013). The indigenous communities were restricted on their customary rights of using natural resources of PAs.

Moreover, extension programme in SWR excluded the participation of local people being affected and involuntary displacement was done. This resulted in conflict between PA authority and displaced people. As a result the dissatisfied people encroached into previous area from where they were relocated.

The conflict between protected area and people is complex in Terai mainly due to population influx, rich biological diversity, and fertile land (Shrestha and Conway 1996; Brown 1995; Ghimire 1994). The increasing demand for natural resources by local people, damage and loss of properties and life by wildlives often created conflicts between PA and people (DNPWC 2015). The widespread park people conflict in some areas resulted in the destruction of flora and fauna, valuable habitat, including ecosystem (DNPWC 2015).

The actions taken by the state to reduce conflicts were not convincing, they were driven by the objectives of either supporting conservation or by political agendas. Government took few initiations for people's participation in conservation by amending some policies like National park and Wild Life Conservation Act 1973, Buffer Zone Regulations 1996 and Buffer Zone Guidelines 1999 (DNPWC 2015). Removal of thatch grasses on a season basis from PA in Terai, zoning regulations for some extraction in the conservation area were some of the example of such initiatives. In this chapter, we put forth the evidence of detrimental effects of not involving people in SWR management and employing involuntary displacement programme.

THEORETICAL CONTEXT

Participation has been an important instrument for conservation and development globally (Brown 2002). Participation is used as a strategy of managing forest resources in the past to fulfill consumption demand of resource dependents population in developing countries (Angelsen and Wunder 2003). Indigenous communities has built customary institutions to use participation as a tool to fight adversities, sustain social values, and enhance transparency (Ostrom 1990). Authors have said that institutionalization of participation gives 'the poor' more voice and choice in development (Cornwall 2006). This 'voice and choice' is a main instrument to motivate people for resource conservation; it helps building collective action.

Traditional practices are developed from collective actions of local communities over generations (Agrawal and Ostrom 2001). International agreements like Convention on Biological Diversity (CBD) also look for

customary use of biological resources in line with traditional cultural practices compatible with conservation; the parties to CBD also emphasize on involving local people to deal with forest degradation (United Nations 1992). Concerning to *Common Pool*[1] resources, studies on forest user groups, farmers management irrigation system, fisheries etc. show that owners have built institution and authority rules to exclude non-contributory, devise monitoring mechanisms and to use graduated sanctions against those who do not conform to the rules (Agrawal 1994). However, scientific conservation logics emerging from western conservation concepts believes which conservation is best achieved by separating humankind from nature and creating wilderness (Colchester 1994). As consequence, American model (western conservation concept) of conserving resources is followed all over world including developing countries where the socio-economic context is completely different (Adams and Hutton 2007). Such approaches are justified on the grounds that "most of the Earth has been colonized by humans only in the last several thousand years" (Butler 1992). Participation has been blamed for having, mostly, captured by elites in the society; often affected by those in the immediate social environment (Adger et al. 2006). Few people who have access to position and power use participation tool according to their need and for self-indulgence (Dasgupta and Beard 2007). Propositions have been made that per unit use of the resources by one user has per unit cost implication on other. The two character i.e., difficulty of exclusion and subtractability, cannot be managed by the local people, therefore, the state intervention is required (Hardin 1968).

Authors have argued that there are no such proved evidences to show that approach of separating humankind from wilderness are successful in conserving biodiversity (Colchester 2012). However, this notion is challenged by development outlook, which acknowledged conservation as a risk to human welfare (Brown 2002). Arguments have also been placed that common pool resources are, at many places, managed by the local community through their traditional institutions, customary practices and norms (Ostrom 2002). Moreover, the studies have suggested that the PA management usually fails when the outsiders initiates or directs the involvement of local communities (Colchester 2012). Valuing above propositions, we would like to refer Ostrom's principles of managing commons which were proposed based on her extensive research work around the world including Nepal. She proposed that

[1] Common pool resources are those resources which are characterized by subtractability (i.e., withdrawal by one user reduces the amount of the resource left for others) and joint use by a group of appropriators (Ostrom 1990).

the rules for governing natural resources should be pertinent to local needs and conditions, can be modified by the affected people and such modification are respected by external authorities (Ostrom 1990), which otherwise would have detrimental effects. It is based on the principles of including local to manage the biological resources therefore, to ensure the good resource governance.

STUDY AREA AND RESEARCH METHOD

This study draws evidences from Dekhatbhuli-1, Dhakka, a block included in core area of SWR after displacement of 146 households. Dhakka lies between 28°46'52.0"N and 80°20'37.8"E. Out of 146 households displaced from "Dhakka" block, we randomly selected and interviewed 43 households (29% of total households). Semi-structured questionnaires survey was administered to sample households, the information were then triangulated with key informant interviews with the reserve officials, local leaders and key persons of the community. We also looked at the tenure of committees formed to resolve the conflict between SWR and displaced people and how it aggrevated the conflict.

We tried to explore three evidences as i) situation before displacement of people, ii) situation after displacement of people and iii) present situation. For this, Google Earth image of three time periods, i.e., 2003, 2006 and 2015 along with topographic map were used.

House unit of 2003 were marked in the Google Earth image, reflected the situation before displacement of the people. It was also verified with house unit of topographic map, published by Department of Survey (DoS), Government of Nepal in 1996. For this purpose, house unit of topographic map was projected in Modified Universal Transverse Mercator projection system (MUTM) with 81^0 Central Meridian and datum as Everest 1830. Later on, it was transferred into World Geographic System (WGS-84) which is compatible with Google Earth. Similarly, available Google Earth image of 2007 for second situation (without people) was downloaded and presented as evidence of after displacement of households. Finally, each house units were marked in the Google Earth Image of 2015 and was verified with reference points from field for demonstrating the current scenario.

Similarly, other factors which can affect the resettlement inside the park such as population pressure and occurrence of disasters were analyzed. The population data from CBS, Google Earth image of 2006 which reflected the

situation before flood and image of 2015 reflecting situation after flood were used. Land cover data of 1993 and 2015, compiled and prepared by Presidential Chure-Tarai Madesh Conservation Development board were used for land cover change analysis of Kanchanpur district. The rate of change was calculated by using equation derived by FAO 1995 and Pokharel et al. 2015.

Rate of change = $((A_2/A_1)^{\wedge(1/(t_2-t_1)-1)})X100$

Where,

A_1= Area of land cover type at time t_1 (1993)

A_2= Area of land cover type at time t_2 (2015)

Lastly, this chapter presented how the extension of PA is aggravating the situation.

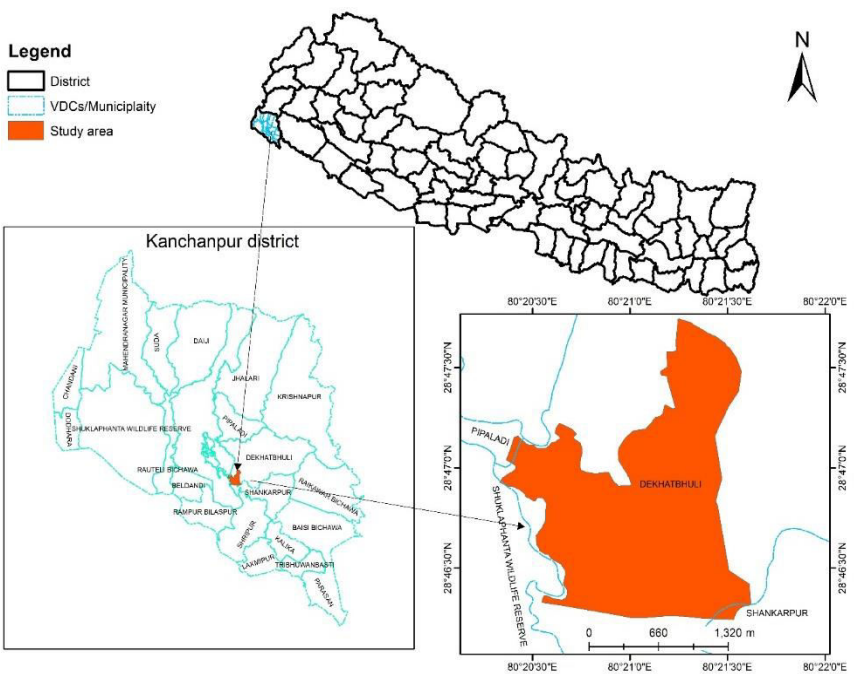

Figure 1. Map showing study location in Nepal.

RESULTS

Relocation History of Shuklaphanta Wildlife Reserve

'Dhakka' of Dekhatbhuli ward no 1 was home to 146 households before displacement, among which 46 households had registered land in the area, and 100 had unregistered land. The major group found in the area was Tharu (an indigenous community), Brahmins, Chettri, Dalits and other caste groups, who migrated from some hilly districts of Far West Nepal. The social institutions were already developed in Dhakka where people maintained and replicated their culture, belief, and practices. These communities were residing in Dhakka before the declaration of SWR. The digitization of the Google Earth image (2003) resulted that 151 house unit were situated within Dhakka block which also resembled with topographic layer. The settlements were concentrated along the bank of districts road connecting Belauri (a town which is about 14 KM south of Dhakka) with national highway. Another cluster of houses were seen along the cart tract which join Dhakka to Chamarkatti and then Sikhalpatti Jai villages. We found that 5800m of cart tract was established before displacement, which indicate sound development of infrastructure during that period (Figure 2).

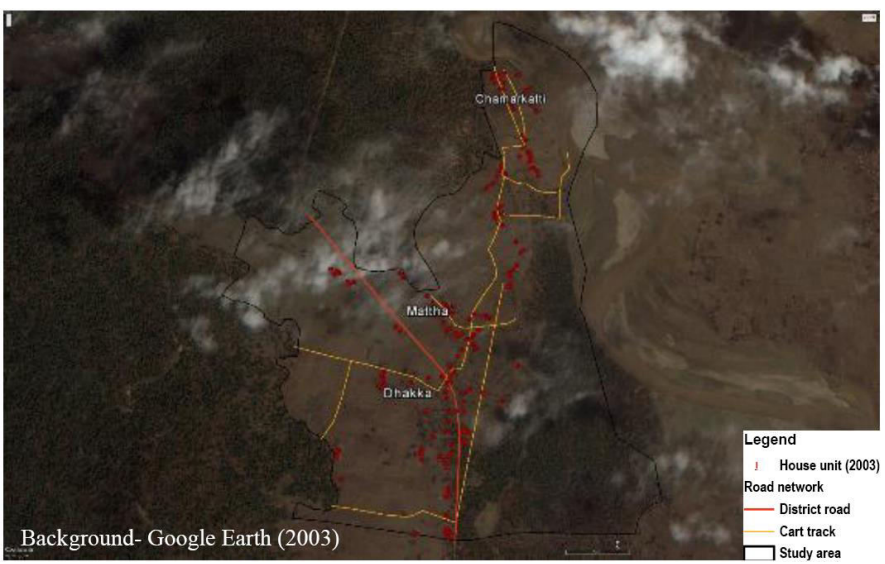

Figure 2. Scenario of Dhakka, SWR before displacement.

During the displacement, 46 households owning registered land in Dhakka were given same amount of land they had. However, 100 households settled in unregistered land were relocated without any compensation. The land provided to 46 households was, however, of poor quality in comparison to the land in Dhakka. The unused 5.8 kilometer cart tract is disappeared after the displacement of settlement from Dhakka (Figure 3).

People resettled in "Dhakka" block in January 22, 2008 which can be observed from the image of 2015 (Figure 4). The settlement is denser and covered larger area than before. The settlement growth is also seen in forested area and recently abandoned flood plain challenging nature conservation as well as life of settlers. The analysis of 2015 image and field verification showed that 584 households were encroached in Dhakka, which is four times more than the households displaced which brought development in the area. The total cart/tracts which were vanished from the areas previously are now increased up to 14.7 kilometer. People have built the hand pumps in the block to fulfil their drinking water requirement. Tea stalls and small grocery shop are opened reflecting rapid growth of settlement and other infrastructures.

Figure 3. Scenario (without settlement) of Dhakka, SWR after displacement.

Management Activities in the Evacuated Area

After displacement of the population from the Dhakka block, three interventions were done by the park authority as: i) marking the boundary of the reserve, ii) placing reserve post and officials and iii) establishing Army base. These activities intent to support the conservation objective of the reserve. According to the interview conducted with reserve officials, other management interventions were not steered in the block. One of the displaced person during the interview raised a concern about their displacement and asked "Why the area is cleared off when PA authority leave the area without any management activities." This reflects that government has not come up with the clear long term management plan which have come if the PA authority had respected local people's need and their ideas for conservation of the area.

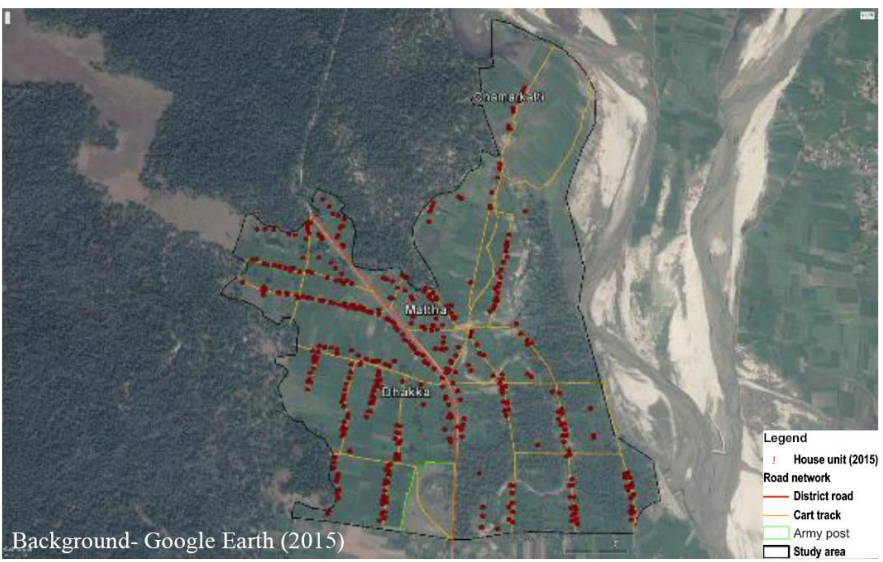

Figure 4. Current situation of Dhakka, SWR (2015).

Population Growth and Other Causal Factors

People have been migrating to plains of Kanchanpur district to increase their social position. The average annual population is increasing every year as

a result population density, since 1981, has been more than double (CBS 2014). According to the Nepal Living Standard survey reports about 85% of this population increase is contributed by the people from rural Far West hills who migrates to the rural Far West Terai (CBS 2011). Almost all the population (97.8%) uses firewood as main energy source, of which 86.7% uses firewood for their household cooking (CBS 2011). The main reason of migration was to diversify livelihood risk in the absence of insurance market (Poertner et al. 2011).

Land Use and Disaster Scenario

Land cover analysis of two decade that is 1993 and 2015 of Kanchanpur district showed that human settlement has increased at the rate 4.1% per year, indicating population pressure on the available land in the district. Although, several agencies are working with SWR for forest conservation over the last two decades, decrease in forest cover by 0.1% per year, questioned the effectiveness of past efforts on conservation. Similarly, increase in barren land and decrease in cultivated land at the rate of 0.2%, indicates the poor food security situation in the district. Peoples in such environmental condition tend to live near forest area to diversify their livelihood options, therefore, to reduce possible risks.

Flash flood is a major threat to people and their properties in Kanchanpur district of Nepal. A study conducted by HELVETAS-Nepal (2015) highlighted the flood characteristics in Doda river system comprise of debris fan and associated flash flood along Chure foot hill and bank scouring, overland flow, channel shift, channel migration and avulsion, inundation (short period as 2-3 days) and severe inundation (longer period as 3-4 moth) are major problem across the downstream (Timalsina et al. 2015). The same study concluded that Doda river system (Chure foot hill to Nepal-India boarder) has eroded more than 900 hectare during 2002-2014, reflected the extent of damaged from flood along the river corridor. Doda village which is nearby Dhakka, was flooded that washed away 65 houses and damaged more than 120 hectare of land between 2006 – 2015 (Figure 5 and 6). These floods affected people also encroached the park area.

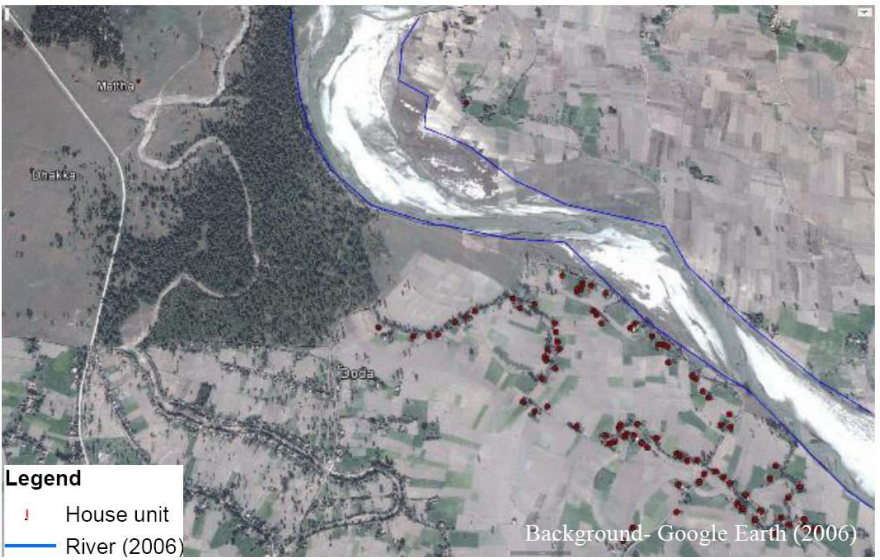

Figure 5. Doda River near Doda village in SWR (2006).

Status of Participation by the Displaced People

Of the total 146 displaced people from Dhakka Block, we interviewed 43 people if they have participated in various types of events, and training organized by the reserve; these include skill and institutional development training such as income generation, agriculture based training, office management, leadership development, gender related, adult literacy etc. However, almost all the respondent replied that they have not got any sorts of training from the reserve management while they were residing inside the reserve. Only 2.3% of the respondent replied that they had taken training related with skill development.

Impact on Livelihood and Resources Assets of Livelihood

We looked at the three aspects of livelihood i.e., physical, financial and social that serves as important livelihood assets of an individual. The indicators of assets are landholding, food sufficiency, Livestock Unit (LSU), education, and the area of land they possess before and after relocation.

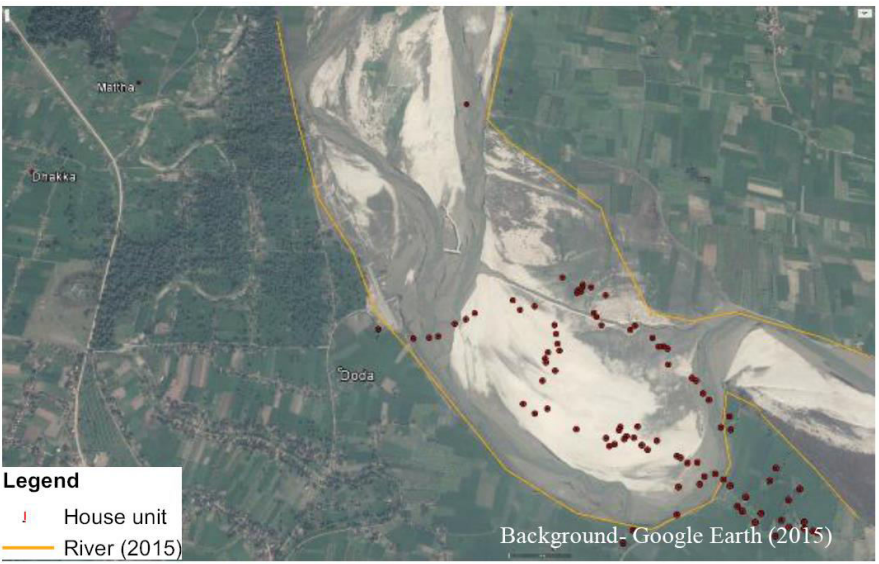

Figure 6. Doda River near Doda village (2015).

The average annual income of the respondent before relocation was NPR 49,429 (1 USD= 73 NPR in 2003) and after relocation was NPR 50,301 (1 USD= 67 NPR in 2007) indicating insignificant increase in the income. The physical capital of the relocated people is not significantly increased in new area except irrigation facility. Of the total 43 respondents surveyed, the percentage having permanent households (at least wooden), have increased from 93 (before relocation) to 95.3 (after relocation). Similarly, water supply situation has also improved; the percentage respondent having access to drinking water supply in their homestead has increased from 97.7 (before displacement) to 100 (after displacement). However, the water supply for irrigation has improved significantly in new place; the respondent replying that the access to irrigation facility has increased from 11.6 to 72.1.

Of the total 43 respondents, the area of land they possessed has reduced from 2.60 hectare to 2.22 hectare per household however land was of lower quality in the new area; bringing significant effect on the food sufficiency. 93% replied that they used to have enough food throughout the year, however, this has reduced to 58.1% after relocation. Similarly, the livestock holding has also reduced from 13.66 LSU to 3.71 LSU. Furthermore, the respondents replied that they were not involved in any kind of decision making in PA management and neither received any kind of trainings when they were staying inside the PA.

The relocation programme also broke the informal institution and connections. All respondents replied that they have lost the kinship mechanisms they developed inside the reserve which has resulted breaking of social safety nets.

Altogether 90.7% of the respondents replied that they were not allowed to take part in planning process and other decision making process when they were inside the vicinity of the reserve. Similarly, 18.6% of the respondents have taken part in decision making process about relocation; of which 97.7% were the people with strong political ties. 86% responded that they were not satisfied with relocation carried out in the reserve.

From the analysis of different assets of livelihood, this chapter found that livelihood of the displaced people is negatively affected, mainly in food security and social assets. Majority of displaced households didn't receive any land as they lack land registration certificate, thus these households resettled again inside the park hoping to get their land back.

The Limitations of Policy Instruments

The protected areas in Nepal were established with the objective of protecting wildlife and their habitats like most other PAs in the world. The conflict between the reserve and the people started with its first relocation programme carried out during the establishment of the reserve in 1976. The two villages namely Hariya and Singhpur of Rauteli Bichawa Village Development Committee (VDC) were relocated; the relocation programme come to an end in 2002 with the relocation of people from Dhakka Block. To address the conflicting claims of relocated people, the government formed its first SWR Land Conflict Resolving Committee in 1981 (Table 1). The first committee was formed in 1981 and the last committee was formed in 2012. Altogether 27 committees were formed during 31 years and 9 months, average tenure of each committee was 1.18 years, with minimum tenure of 23 days to maximum of 5 years and three months. Majority of these committees were formed after the adoption of parliamentary democracy in 1990. The committees were formed to fulfill political interest and to increase vote banks. The consequences was not standing on the decisions made by previous committees as a result, many people have registered their name as the relocated people in the hope to get land or compensation from the government butnone of the committees could complete their work. This has increased the

dissatisfaction among the people. As a result 584 households encroached the Dhakka Block.

Table 1. Tenure of the SWR Land Conflict Resolving Committee

Committees	From	To	No. of Days
1	1/16/1981	8/17/1981	214
2	1/16/1982	6/18/1984	885
3	1/6/1986	6/6/1986	152
4	6/8/1986	6/12/1905	1924
5	NA[2]	NA	NA
6	7/20/1992	12/10/1992	144
7	4/23/1993	4/10/1994	353
8	5/19/1994	12/11/1994	207
9	4/17/1995	6/16/1995	61
10	6/23/1995	7/15/1995	23
11	4/15/1996	7/15/1996	92
12	NA	NA	NA
13	6/9/1997	1/13/1998	219
14	5/9/1998	NA	NA
15	10/9/1998	4/13/1999	186
16	3/19/1999	9/21/1999	186
17	2/4/2000	NA	NA
18	7/21/2000	NA	NA
19	3/24/2002	1/14/2003	296
20	3/15/2004	5/15/2004	61
21	8/28/2006	7/14/2007	320
22	8/20/2007	7/15/2008	330
23	1/15/2009	7/17/2009	183
24	10/24/2009	7/14/2010	263
25	7/17/2011	11/13/2011	119
26	11/14/2011	1/13/2013	426
27	4/13/2012	10/16/2012	186

DISCUSSION

Achieving global conservation agenda through national interventions has been an important milestone in Nepal. However, the approach of displacing people from PA for biodiversity conservation was not coherent with the local

[2]NA: The exact date of the start of the tenure of the committee is not available.

conservation and development needs. The strategy adopted by government to displace people for conservation has been increasingly questioned by several authors as this brings social inequalities, and break down peoples social safety nets (Agrawal and Redford 2009). We found that relocated people have lost their important livelihood assets due to relocation programme, the finding is supported by another study conducted by Lam and Paul (2013). Displacement of local communities from their lands without participation and agreement in SWR has brought the detrimental effects to the biodiversity conservation, as a result the people encroached the displaced areas that challenged the command and control management system as also concluded by other authors (Andrade and Rhodes 2012; Fu et al. 2004). It is important to note that the local people were not involved during the preparation of relocation plans as a result the management authority failed to achieve peoples acceptance of the conservation plans adopted for the reserve as has been practiced in other conservation approach in the world (McLean and Stræde 2003). People thought that displacement from SWR as a rejection of rights to resources (Brown 2002). Authors have presented that the locally developed conservation plans and process are comprehensive, sustainable and have higher acceptance rather than the plans imposed by external authorities (Ostrom et al. 1999).

We analyzed that the problem of SWR raised with lack of local participation and has taken multi-dimensional shape with weak management governance. The problem has aggravated and became complex with population growth, flood and its own extension. However, the state authority assumes that the problem is straight forward and takes the management interventions unilaterally. The quality land required for increasing population growth is shrinking in the district with the increase in the water induced disaster and also with increase in protected areas.

The people, in search of their safety nets, moved into the protected areas where these displaced peoples find their safety nets. Sunderlin et al. (2005) found that peoples dependency on forest resources increases with increasing population growth and with scarcity of arable lands. We found that the people have encroached the area not just they are not happy with the relocation, it is because of the approach taken by government to govern the reserve management, time taken by the government to address the peoples need timely, and not recognizing local people's right to resources, and not involving them in the extension programme development process right from the beginning. In addition, frequent changes in government's management have delayed solution of problems. The situation has not become worse like current

situation if the government has made relocation programme comprehensive and if the local people were involved.

Here we are not questioning the government's objective of addressing the global conservation agenda through its protected area management. We are, in fact, analyzing that the approach taken by government was not suitable to the local context. The government approach in protected area management is undoubtedly changing, for example in case of Annapurna Conservation Area, where the local people are provided the rights to manage their own resources. The management decisions should be developed based on comprehensive and participatory planning, where local people's voices are heard and their choices are taken care of.

Nobody can control the migration of the people as these are guided by the need of the people to live with secured livelihood condition. However, asset in our hand is comprehensive conservation and development planning. We can involve local people, ask them the ways to protect wildlife and other natural resources.

CONCLUSION

Nepal has created milestone in conservation and participatory management of natural resources in the world. The participatory model in forest management has showed positive results in forest conservation, capacity building and governance, however, PA is often blamed for inadequate participation of local people and stakeholders. The establishment and extension of PA in Nepal is driven by the political agenda of achieving global conservation goals. Moreover, the categorization of PA is led by international conservation criteria, which often doesn't suit social, cultural and political context of different local areas. In Nepal, majority of PAs were declared with insufficient consultation with local people. This led to the conflict between PA and people. The involuntary displacement of households from SWR especially indigenous communities resulted negative social impact including restriction on people's customary rights to access natural resources and direct impact on livelihoods. It is important to note that the pressure of local people on the PA is attributed by multiple factors such as population growth, frequency of disaster (flood), government policy and local and national politics. The conflict between PA and people can affect the PA ecosystem that can degrade wildlife habitat for which the conservation is aimed at. To avoid this, an integrated planning and management of PA that includes the planning of all

affecting factors is necessary. Yet, assurances of local participation particularly those who are affected is essential.

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Chapter 5

CONTESTED FORESTS: INSIGHTS FROM THE BILIGIRI RANGASWAMY TEMPLE WILDLIFE SANCTUARY (INDIA) REGARDING THE UTILISATION OF FOREST RESOURCES

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ABSTRACT

A considerable part of India's geographical area consists of forestlands, which provide essential ecosystem services. Such resource settings are often non-exclusive and characterised by complex tenure situations, provoking conflicting assertions over access to and use of the natural environment. This chapter examines the complex local circumstances within the boundaries of the Biligiri Rangaswamy Temple (BRT) Wildlife Sanctuary, in Southern India, which was declared a Tiger Reserve in 2011. The conditions under which utilisation of the forest occurs and the facilitation of the continuous interaction with the ecosystem is analysed. Particular focus is given to institutions and

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peoples' lived practice(s) in terms of utilising forest resources. The chapter seeks to understand the situational contestation inherent to the existing institutional structures in the forest management inside protected areas in India. Embedded in a social scientific approach, two months of fieldwork were conducted between July and September 2011 in a forest settlement called *Kalyani podu*, working with forest-dwelling people from the Soliga community. This chapter draws on an ethnographic research approach, applying qualitative methods of participant observation, ethnographic interviewing and semi-structured expert interviewing. Research shows that forest areas provide an essential source of provisioning and cultural services to the forest-dwelling people. The diversity of utilisation of the forest resource is subject to restrictions enforced by state authorities, whereas local autonomy to devise regulative systems was lacking. In this situation of quasi-authorisation, informal agreements are to some extent transformed into formally sanctioned rules, through the implementation of the Forest Rights Act 2006.

Keywords: forest, protected area, institutions, lived practices, ethnographic research

INTRODUCTION

Forests have immeasurable value, acting as carbon sinks, protecting biodiversity and providing essential ecosystem services (Nagendra and Ostrom 2011). Forest areas in India, as resource settings are often non-exclusive in their utilisation and characterised by complex tenure situations, provoking conflicting assertions over access to and use of the natural environment (Chopra and Dasgupta 2002; Kothari and Pathak 2006). In order to understand forests as *contested space* it is necessary to review the history of forest management and conservation policies in India.

In nearly all provinces of India ancient systems of community forest management were in place under different types of customary common property regimes before the British rule (for a detailed documentation see e.g.: Guha R. 1983b; Guha R. 1983a; Guha R. 1996; Shiva 1988; Poffenberger and McGean 1998; Sivaramakrishnan 1999). Codified forest policies and laws were initially enforced countrywide during the colonial period. In this context, Agrawal (2005) refers to *the making of the forest*, when forest began to be viewed as resource for the purpose of appropriation between competing users (Agrawal 2005). The colonial interventions were largely guided by revenue and commercial considerations and ecological aspects were of secondary

importance (Hazra 2002). According to Sivaramakrishnan (1999) the far-reaching interventions were enforced in a manner, which viewed the ecological and physical landscape in India in isolation from the existing social realities (Sivaramakrishnan 1999). After India gained independence in 1947, industrial use of forests remained an overall priority and it was only from around the 1988s onwards that theecological and social functions of forests were explicitly put above commercial ones (Kothari and Pathak 2006). In the 1990s, India introduced a departure from a state-centric approach towards a more decentral, participatory approach of managing forest areas, see i.e., the Joint Forest Management program.

In line with the management practices of forests and ecosystems, relevant policies also relate to biodiversity and wildlife conservation. The establishment of protected areas (PAs) in the form of national parks and wildlife sanctuaries has been central in conservation policies of India since the 19th century (Colchester 2004). In India, biodiversity conservation policy was embarked upon based on a strategy of declaring a network of PAs to protect the country's wildlife (Mandal et al. 2010). This applied model of wildlife conservation was strongly influenced by the United States model of nature conservation, advocating a separation of wildlife from people (Colchester 2004). As of 2011, nearly 5% of India's land area had been declared as PAs, legally established under the Wildlife Protection Act (WLPA) adopted in 1972. The largely forested areas that were declared PAs, however, were not pristine forests or empty wilderness but often inhabited and utilised by rural, forest-dwelling communities (Kothari and Pathak 2006). Indigenous people constitute the majority of these people living in or alongside PAs and were therefore, disproportionally affected by these developments (Wani and Kothari 2007b). Estimates suggest that in India alone, there are 3 to 4 million people residing inside PAs, and many million more in adjacent areas depending on natural resources from these areas (Wani and Kothari 2007b). To what extend these communities can access and use the ecosystem differs greatly across India depending largely on the local conditions and institutional setting.

The WLPA provides legal guidelines and preambles for the establishment of PAs. Its statutes provide for a highly centralised concentration of power, with the exclusive rights of management lying with the forest department (FD), and utilisation of natural resources is not intended (WLPA, GoI 1972). The establishment of PAs lead to the subsequent transformation of forest use systems, which affected the cultural practices that were embedded in the landscape and resulted in the erosion of knowledge and practice (Mandal et al.

2010). The implementation of certain conservation policies also sometimes failed to address the issue of biodiversity conservation (Torri 2011).

As of 2016, a network of 733 PAs have been established across India, in line with the International Union for Conservation of Nature (IUCN) categories, covering 1,60,901.74 sq. kms, 4.89% of the total geographical area (ENVIS 2016). Comprising 103 national parks, 537 wildlife sanctuaries, 67 are conservation reserves and 26 community reserves (ENVIS 2016). India is also the land of two biodiversity hotspots[1], the Himalayas and the Western Ghats. Wildlife and forest have been designated as priority sectors at the national level and PAs became assiduously promoted as ecotourism attractions, luring large numbers of visitors (EQUATIONS 2007). The WLPA generally established schedules of plant and animal species, outlawed wild hunting or harvesting of the defined species and prohibited logging as well as the practice of shifting cultivation within PAs. An amendment to the WLPA brought community reserves and conservation reserves, as new categories of PAs and a 2003 amendment made provision of punishment and penalties for offences under the Act more stringent. Similar to earlier forest policies (i.e., the Forest Conservation Act 1989), the WLPA generally identified environmental protection and the recognition of the rights of local communities as mutually irreconcilable objectives (Bhullar 2008).

With time the potential of collaborative approaches in PAs and the role of local communities in the management of government designated areas, and equally, areas managed by such communities themselves, found more recognition (RLEK 1997; Kothari and Pathak 2006). On the international level the IUCN changed the PA classifications and created a matrix with different governance types[2] ranging from strict nature reserves to community conserved areas (Dudley et al. 2010). In India, i.e., a wide range of community-conserved areas (CCAs) are managed and conserved by local communities. However, they often lack recognition and adequate support (Pathak et al. 2007). The debates decentralisation of natural resources governance generally revolved around, co-management and collaboration between local community and governmental executive agencies and private participatory approaches to governance. At its most basic, decentralisation generally aimed at achieving democratisation, one of the central aspirations of just political governance

[1] The concept of biodiversity hotspots was developed in the late 1980s defining bio-geographical regions with a significant reservoir of biodiversity under anthropogenic threat (Conservation International, n.d.).

[2] For a detailed picture of the IUCN Protected Areas Categories System please see: (IUCN online n.d.).

(Agrawal and Ostrom 2001). On the grounds of greater participation and responsiveness to local needs and aspirations, it was advocated on theoretical grounds that locally accountable authorities will make a decision that will benefit local people and at the same time will be ecologically viable (Ribot 2004).

On January 1st 2008, the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights Act) Act 2006, also referred to as The Forest Rights Act (FRA), entered into force. The Act marked a radical shift from existing forest legislation because it challenged the centralised top-down governance approach (Roy and Mukherjee 2008). For the first time the rights of forest-dwelling people were recognised while formulating Indian forest folicy (Roy and Mukherjee 2008). Tribal rights activists perceived the legislation as a framework to rectify 'historical injustice' in opposition to many environmentalists, who feared the law might lead to deforestation and endanger protected wildlife (Roy and Mukherjee 2008).

The FRA mandates the vesting of 14 kinds of individual and community rights over forest lands and forest produces, regardless of the legal status of the forests. Thus, it provides for scheduled tribes[3] and other traditional forest-dwellers[4] residing on forestlands to file forest rights claims under the Act. The status report on implementation of the FRA for the period ending on March 31st 2012 showed that the majority of the distributed titles were individual land rights and that community rights provisions were rather poorly implemented (GoI 2012).

The Ministry of Environment and Forests (MoEF) is principally responsible for implementation and in a multilevel procedure that involves representatives from the local level, the FD, the Revenue Department, and Tribal Welfare Department in the different committees. With regard to established PAs the FRA does likewise apply, however, in many states there is the impression that tiger reserves are exempted from the FRA (Interview Rai, 20.7.2011; GoI 2010:128). The FRA mandates a process for determining *Critical Wildlife Habitats* (CWH) inside PAs constituting a different category than *Critical Tiger Habitats* under the WLPA. The Indian government can notify these defined areas to be kept fully protected for the purpose of wildlife conservation after open process of consultation by an Expert Committee. The

[3] The classification of *Scheduled Tribe* is of administrative standing. As recognized in India's Constitution 1949, the Fifth Schedule (Article 244) provides for the administration and control of Scheduled Areas and Scheduled Tribes. Due to their disadvantaged condition special protection and certain benefits are designed.

[4] Defined as those living in forests for at least three generations (75 years).

FRA also includes provisions for potential resettlement under certain conditions, namely when activities inside a CWH are considered sufficient to cause *irreversible damage* and when co-existence was not considered possible. In that case the informed consent of the *gram sabha*[5] is required in writing and resettlement packages need to be agreed upon (FRA 4(9)(b)-4(2)(e)). However, relocation takes place in PAs, particularly in tiger reserves in violation of the provisions of the FRA and WPLA, and furthermore, it is recommended that CWH should not be considered as necessarily human-free, but rather free of activities that are violating conservation activities (Workshop Recommendations. Anon 2011).

With regards to biodiversity conservation the FRA fosters the active participation of forest dwelling communities insofar as the right of a community to *"protect, conserve, regenerate or manage any forest or community forest resource that has traditionally been protected"* (FRA 3(1)(i)), is recognized. The FRA emphasises the fact that the majority of forests have been under human use in history and broke new grounds in the debate of control over resources *"by arguing for a layered governance model"* (Lele et al. 2011). This approach is extremely interesting and raises questions about concrete institutional arrangements and structures of community management and protection of forests. Which institutions enable collective action? Who gains from the efforts and how are benefits shared? What incentives exist in the concrete local setting to engage in management and conservation efforts? Additioanlly, the way in which a decentralised reform shares responsibilities and rights is also relevant. As for participatory approaches and co-management arrangements, the powers may be shared with local communities but are not clearly transferred. Ribot (2004) argues that some initiatives might not fall under decentralisation reforms but are formally contracting arrangements for the purpose of soliciting participation in decision-making (Ribot 2004). Although the FRA does not provide for community ownership of forest areas, it stipulates for local authority over management, protection and ensures traditional rights. It may be viewed as a powerful instrument to increase peoples' stake in forest utilisation and resource management.

[5] A *gram sabha* is defined as a body consisting of persons registered in the electorial rolls relating to a viallage comprised with the area of *Panchayat* at the village level according to Article 243(B) of the Constitituion of India. Whereas *gram panchayats* are generally recognized as constituting the smallest form of local self-governments at the village or small town level (several hamlets can come under one *gram panchayat*), a *gram sabha* is the legally recognized body of village/hamlet adults and includes every person over eighteen years of age.

In the discourse of appropriate roles for governments, private actors and communities in forest and natural resource management, devising enhanced governance systems is a major issue (Dietz et al. 2002). There are considerable discrepancies in scientific literature and among the policies of different countries on the issues of how to best govern and manage forests and sustain and/or preserve the natural resources. An increasing number of in-depth field studies have dealt with the considerable collective action potential of rural communities and concluded that people dependent on the forest resources may in many cases be best placed to manage these (Wade 1987; Bromley 1992; Ostrom 1995; Baland and Platteau 2000; Agrawal and Ostrom 2001). In the first instance, local self-management requires certain framework conditions in order to be likely to form and sustain itself over time. While the governance of forests in India is mostly centrally organised, especially in PAs, the property rights regimes can in fact comprise a multitude of informal customary rights and formally codified property rights.

Given the history of forest policy and conservation policies in India, the forest as a space of contestation becomes evident. There is a lack of research on this inherent contestation and on *local practice(s)* from the perspective of the local *users*. This chapter looks at these issues and aims to illuminate – *under which conditions forest resources were available in BRT and how their continuous utilisation was facilitated*[6]. With respect to specifications on circumstance, property rights and other institutions with those historical, ecological and cultural situations (Wani and Kothari 2007a), the purpose of this research was to understand how people, interacted with the ecosystem and related to the forest resources. By trying to devise an understanding of *lived practice(s)* and comprehend complex realities the aim was to shed light on the situational contestation as inherent to institutional structures in current forest management. The findings are analysed within the theoretical framework of institutional economics and property rights regimes. According to Vatn (2005), use-related activities in forests inform *institutions,* conventions and rules, characterised as interactive and mutually constitutive in relation to behaviour (Vatn 2005) and are therefore extremely important to understand.

[6] This chapter builds on the research that I conducted for my thesis in 2011, graduating in International Development at the Department of Development Studies, University of Vienna.

STUDY SITES AND THE METHODOLOGY

The research for this chapter builds on an ethnographic research approach and the first-hand exploration of the *Biligiri Rangaswamy Temple Wildlife Sanctuary*. With the much-appreciated support of ATREE,[7] I conducted twomonths of fieldwork in BRT between 26th July and 17th September 2011. The BRT field station operated by ATREE provided me with infrastructural necessities and allowed me to gain initial access to forest settlements.

BRT wildlife sanctuary is located between 11-13° N latitude and 77-78° longitude, covering an area of 540 km^2 in Southeastern Karnataka, bordering on Tamil Nadu in South India. The area is rich in biodiversity and the major vegetation types are dry deciduous, scrub, evergreen, savannah, and shola forest (Rai and Setty 2013). It was declared as a PA in 1974, under the Wildlife Protection Act of 1972. In the year 2011 BRT was declared a *tiger reserve*, yet, at the time of the research and even afterwards it is still commonly referred to as wildlife sanctuary, thus, this term is used for the present chapter.

The forest areas in BRT are inhabited by the indigenous forest-dwelling Soliga tribes, who are formally recognized as Scheduled Tribes[8]. Around 16.000 Soligas live in forest settlements inside the sanctuary or around BRT (Rai and Setty 2013). A total of 61 *podus*[9] are spread throughout BRT, whereof seven are located within walking distance to the Atree field station. After visiting all of the surrounding podus with a field assistant, who was known to the tribal leaders and most of the *podu* inhabitants, I based the decision on the specific field site on ethnographic considerations on access (Atkinson et al. 2001; Fetterman 2010; Brown and Dobrin 2004) and on peoples' description on forest resource dependency[10].

During the two-month period, I worked with the people from *Kalyani podu*, a small settlement counting 12 families. *Kalyani podu* was located 2km away from the field station; I could walk there easily along the main road, and

[7] The Ashoka Trust for Reserach in Ecology and the Environment (ATREE) is a reserach institution in the area of biodiversity conservation and sustainable development based in Bangalore, Karnatka, India.

[8] The classification of Scheduled Tribe is of administrative standing. As recognized by India's constitution 1949, the Fifth Schedule (Article 244) provides for the administration and control of Scheduled Areas and Scheduled Tribes. The Scheduled tribes are entitled to special protection and certain benefits.

[9] *Podus* describe small forest settlements, some of which have been recognised as villages under the Forest Rights Act 2006.

[10] All persons that we (my field assistant and me) spoke to during the first visit, explained that they were using the forest in their day-to-day activities, only a few people went out to work.

did not require a jeep or a driver. In order to decide on space and time sampling independently and to gain trust and establish a rapport with the people, I decided to conduct the first phase of fieldwork without a field assistant[11]. Through participant observation practices were accessible and essential for a deeper understanding of what people related to in later informal conversations and interviews (Emerson et al. 2010). On a normal fieldwork day, I walked to the *podu* early in the morning and returned no later than 5:30pm, as many wild animals came out to the lakes along the main road after it gets dark. It is important to note that neither the *podu* nor the forest area can be considered a fully public place, and although I had permission from the tribal leader from *Kalyani podu* to take part in daily activities, my work depended crucially on peoples' individual consent and approval. Over the weeks more and more people agreed to take me with them and mutual confidence developed. On most days, I joined a group of three to five people with a herd of goats and sheep or cattle for grazing and collection of forest resources. In a single file, we walked on one of the countless dirt tracks into the forest often for hours until we reached higher open-space grasslands and different types of forests.

Participant observation during fieldwork included filtering and systematically understanding processes and problems relevant for the guiding research question. Furthermore it involved producing written accounts and descriptions that bring versions of the lived experience to paper (Emerson et al. 2010). The field note writing was divided into different phases, trying to bring *"versions of the lived experience to paper"* (Dudley et al. 2010). In the first phase of fieldwork, which required detailed field notes at great length, field notes were formative and rather descriptive. After initial orientation, a phase of focused observation began, opening into selective observation of resource utilisation (Flick 2006).

The original field note writings were reordered and revised during the fieldwork and analysis, and also included remarks on practical challenges and methodological questions. Different conceptions exist in literature on the process of capturing and recording of observations in ethnographic writings. While for Clifford *"ethnography translates experience into texts"* (Clifford 1986), Richardson finds the core of ethnographic writing as *"narrating"* (Richardson 1990). For the present chapter an integrative strategy according to Emerson, et al. (1995) was used. It allowed field note writings to be inserted in

[11] The unorthodox approach to work without a (male) field assistant, being a woman, and moving around with people I could not easily communicate linguistically with made several persons uncomfortable.

the results in order to allow coherence between narrations and insights from interviews as well as data from participant observations. Thereby also facilitating flexibility (Emerson et al. 1995).

Informal conversations and other forms of dialogue that occurred during fieldwork allowed me to fully understand observed behaviour and practices. As I did not speak Kannada[12] well enough to conduct interviews myself, I needed to work with an interpreter for the second phase of fieldwork. While I noticed that women became more comfortable with me being around, i.e., we frequently shared our lunch, I noted that men continued to avoid meeting me. Based on that observation, I became concerned about the alteration of a conversational situation caused by a male interpreter and made every effort to find a female interpreter for the ethnographic interviews. Through an announcement on the YETI platform,[13] I got in touch with Shruti, who was bilingual in English and Kannada. She worked with me from 22nd of August 2011 onwards for a period of four weeks. Shruti translated everyday communication, providing contextual insights. Informal talks and conversations with people that we accompanied occurred on site and often spontaneously. When a narrative lengthened, word-by-word translation became demanding and we asked for an interview. We asked the person for permission to switch on the tape recorder in order to have audio recordings and obtained oral consent before the interview started. The interviews were conducted in line with Heyl (2010), highlighting the ethical engagement with all interview partners and the broader social context affecting them, the interview process and the project outcomes (Heyl 2010). When exploring the *lived practice(s)* in resource utilisation the aim was to gather people's own interpretation of their experience and most importantly recognise their value (Atkinson et al. 2001). A total of 16 extensive unstructured interviews were conducted and the numerous informal talks were included in the field notes. The interview sample size was guided by the attempt to obtain an understanding of practices, values and circumstances of individuals and the surrounding natural resources being studied and were not finalised in advance. The selection was governed by relevance for the topic in contrast to representativeness (Flick 2009). All interviews took place in or around the *podu* or inside the forest.

[12] Kannada is the official and administrative language of the state of Karnataka and one of the scheduled languages of India.

[13] YETI standing for Young Ecologists Talk and Interact is a conference for ecology students and reserachers in India. www.meetyeti.in; last access: 24.06.2016.

Furthermore four explorative and systematising expert interviews were conducted in order to get orientation in an unknown field and gain access to exclusive knowledge (Bogner and Menz 2005). The first interview I conducted with Dr Nitin Rai a research fellow at ATREE, at the organisations main office in Bangalore on 20th July 2011, right before I started fieldwork in BRT. Then, I interviewed Arshia Bose, a PhD fellow and researcher previously working for Kalpavriksh[14], on July 25th 2011. Thirdly, I conducted an interview with Dr Siddappa Setty, also a research fellow at ATREE, on September 10th 2011, at the BRT field station. Lastly, Mr. Prabhu the secretary of the BR Hills Large-scale Adivasi Multi-Purpose Society (LAMPS) was interviewed by Shruti in Kannada, carried out on September 13th 2011.

Table 1. Overview of recorded interviews

Interviews	Date	Time	Location
Interview 1	23.8.2011	2:33pm	Forest
Interview 2	24.8.2011	5:20pm	Kalyani podu
Interview 3	25.8.2011	12:37am	Lake
Interview 4	25.8.2011	1:30pm	Kalyani podu
Interview 5	30.8.2011	10:55am	Kalyani podu
Interview 6	30.8.2011	12:40am	Kalyani podu
Interview 7	30.8.2011	2:02pm	Kalyani podu
Interview 8	6.9.2011	12:02am	Forest
Interview 9	9.9.2011	10:26am	Forest
Interview 10	9.9.2011	8:21am	Forest
Interview 11	10.9.2011	11:40am	Forest
Interview 12	10.9.2011	12:07am	Forest
Interview 13	13.9.2011	3:54pm	Kalyani podu
Interview 14	14.9.2011	9:46am	Forest
Interview 15	14.9.2011	10:48am	Forest
Interview 16	16.9.2011	10:28am	Kalyani podu
Interviews	Date	Time	Location
Interview Rai	20.7.2011	11:15am	ATREE office, Bangalore
Interview Bose	25.7.2011	5:13pm	Bangalore
pers. comm. C. Madegowda	26.7.2012, 20.8.2011 and 11.9.2011	~1:00pm ~11:00am ~6:00pm	ATREE field station, BR Hills
Interview Setty	10.9.2011	7:45pm	ATREE field station, BR Hills
Interview Prabhu	13.9.2011	1:42pm	LAMPS office, BR Hills

[14] Kalpavriksh Environment Action group is a non profit organisation working on environmental and social issues, established in 1979 it works on environmental awareness, campaigns, litigation, research and other areas. www.kalpavriksh.org; last access: 25.06.2016.

Transcriptions of all recorded interviews were made using the F5 software, immediately on the evening on the day of the interview. The transcriptions were then translated to English. All data gathered in the research process found recognition in the analysis. In line with the qualitative-interpretative principles of Mayring's content analysis, the material was analysed in a multi-step procedure (Mayring 2010). Categories were inductively derived and continuously re-checked in order to ensure the understanding corresponded to its genesis. The ethnographic interviews were pseudonymized and numbered consecutively; in expert interviews, the names were retained.

In terms of conceptual and practical challenges the twin problem of access and time (Smith 2010) essentially shaped the way and occurrence of how and what was obtained. Though the eight week period was genuinely short for an ethnographic research approach, it was considered as feasible for researching the complexity of the local circumstances. The role as an outsider comprised a number of dimensions, such as the unequal power relationships inherent to ethnographic accounts. On the one hand this created a challenge in the data gathering processes but on the other hand it revealed the underlying structural elements on which research is based upon. The latter shall not remain unmentioned. Another aspect of access was the sensitivity of certain topics: it seemed that people refrained from bringing up certain issues to my attention, or at times were reserved in giving answers. During a conversation a person would sometimes hesitate to respond or just turn away saying: *"there is much work that needs to be done"* or *"I don't know, I don't understand"* (Interview 7, 30.8.2011). In the unstructured interview situation, avoiding or giving evasive answers on certain issues was recognised and formed part of the findings.

A substantial limitation in this research was my narrow knowledge of Kannada. Not being familiar with the underlying logic of words, signs and symbols people used curtailed by my ability to fully obtain access to the setting and enter the world linguistically. Yet, the strongest argument for the chosen approach was the significance of data collected through observations, and the firm effort to learn about a particular aspect in order to generate new understandings, in commitment to ethical claims.

RESULTS

The use-related interactions[15] of people from *Kalyani podu* with the surrounding forest areas permeated important spheres of life. The utilisation of forest areas was shaped by uncertainty and at the same time provided a means of livelihood (provisioning services) and was also part of people's cultural heritage. The process of utilisation of the forest was perceived as an active process, whereby people allocated their time, labour, materials and knowledge and in return, obtained material, non-material, or spiritual benefits. According to the Millennium Ecosystem Assessment 2005, this chapter draws on the existing categories of services (MEA 2005) in order to explain the utilisation of forest by people from *Kalyani podu.* There is no doubt that BRT as a whole provides services to different *users* and *user* groups, whereby this chapter focuses on the local forest-dwelling people, native to the area.

Forest as a Source of Provisioning Services

Drawing from observations and interviews firewood collection was the most immediate and important forest resource obtained from the forest, due to a lack of affordable alternatives. One woman explained:

> "When I come to the forest for grazing, I collect firewood. I need to roam through the forest, I find broken branches and something fallen down and pick it up, then carry it home. I will light my firewood and I cook […] it's a kind of work, it is work outside the house." (Interview 1, 23.8.2011)

Firewood was generally perceived as something naturally provided by a *"healthy forest,"* it was found to be i.e., available due to elephant activities (Interview 14). Branches that were broken off or unrooted trees that had dried out were commonly collected and carried home on the head. In the field setting, the allocation of firewood did not appear conditional to specific efforts, as it may be the case for other forest products. It was noticed that people disagreed on whether the stock of firewood increased, decreased of remained stable over the last years (Interview 3, 5, 8, 15). It was argued that

[15] Use-related interaction describe every interaction and activity that comprises utilisation of forest resources.

the amount of accessible firewood had increased due to the problem of overgrowth and that mistletoe infestation, which impaired the condition of the forest, as the following quote shows:

> "There is nothing other than lantana growing, the trees died and it has all become waste." (Interview 13, 13.9.2011)

Another statement points to the contrary, that stock decreased and that it became harder to collect firewood:

> "in nearby areas you won't get good firewood, now we have to go to much further and search for it and it's difficult to carry so far." (Interview 5, 30.8.2011)

The divergent statements point to heterogeneous perceptions on resource conditions and reflect experienced insecurities in claiming an assertion. Apart from firewood collection many other forest resources were collected, adjoining fields provided i.e., quick fodder in busy times of work and for sick animals that could not be taken for grazing. People harvested young sprouts on huge bamboo plants as ingredient for *sambar*[16] and plucked wild guava during grazing times.

In subsistence, the natural resources collected also included construction materials, medicinal plants, fodder, leaves, berries, honey, greens, tubers, gooseberries and lichen, all of them are referred to as Non-Timber Forest Products[17] (NTFPs). The forest resources naturally fluctuated with seasonal variations and with availability. One man explained that:

> "in the past there was plenty of medicine in the forest available, previously our people used to burn the forest, to develop the forest, but now even if we search for it, medicinal plants have disappeared." (Interview 5, 30.8.2011)

Several people stressed that the decrease in medical plants was troublesome and appropriate measures to halt it were needed (Interview 5, 11, 14). In addition to traditional healthcare, alternative modern medicine was

[16] *Sambar* is a popular dish in southern regions of India; it is a vegetable stew or chowder based on a tamarind and pigeon peas broth typically varying among states and environment.

[17] Benefits derived from timber yield in protected areas are stricly reserved for governments and its executive agencies and are not appropriated by *users* who interact with the forest.

prevalent in BRT through the NGO *Vivekananda Girijana Kalyana Kendra*[18] (VGKK) since 1981. Whether the access to modern medicine has brought a loss in the traditional medicinal knowledge or change in health status (Ghosh et al. 2007) goes beyond the scope of the research question. However, the views on altering forest conditions and the shortage of medicinal plants available in the forest, were recognized with respect to provisioning services. People frequently expressed that they considered a shortage of a medicinal plant, a tuber, a berry or another renewable resource to be the result of the prohibition of anthropogenic seasonal burnings. Actual practices of utilisation had to be continuously adapted to availability of resources and access/allowance of *users*.

Livestock breeding was also an important source of livelihood for people from *Kalyani podu*. Several families had goats and sheep, the meat was eaten or sold, and cattle livestock was used for for milk production and agriculture[19]. For animal grazing around three or four people, who were more often than not time related to each other, went out together, depending on who had work on that day outside the village.

> "whoever has time will come, when I have no coolie I will go for grazing […] we all talk and then we will go this way, we will decide and go." (Interview 1, 23.8.2011)

Women and men joined in together for grazing goats and sheep, yet cattle herds were not grazed without men. People grazed livestock at various places inside the forest and often took cattle further up to mountain pastures. I observed that grasing places naturally overlapped between the seven *podus* around BR Hills and occasionally two groups of people from different *podus* joined and continued together. At other times groups only met, talked for a while, split again and continued to different areas.

[18] VGKK was founded in 1981 and run a primary school and secondary modern school (also run as a residential school for children coming from interior parts of the sanctuary) in BR Hills. While compulsory education up to the 8th grade is provided there, higher education is not available within BRT. VGKK also run a hospital with free medical supplies and they collaborate with ATREE in monitoring programmes.

[19] Cattle dung was used as organic fertilizer and oxen were used for harrowing fields.

Commercial Utilisation of Forest Resources

In BRT several NTFPs are extracted from the forest for both commercial and domestic use and Soligas have engaged in NTFP commercial collection for centuries (Sandemose 2009). After the establishment of the PA, forest communities living within the PA were tolerated to collect NTFPs under certain conditions. At the time of the fieldwork specified NTFPs were collected and sold through the government run cooperative called LAMPS (Large-scale Adivasi Multipurpose Society), which held harvesting rights.

People appropriated nature and its use as a means of subsistence and cash income:

> "I go with my goats for grazing, from that area; I will also bring firewood for my house. If somebody asks urgently for firewood, I will sell it and I get INR 20 for it. Other than that, I will only collect for the society[20]. They will tell us and then we will collect amla, honey and lichen. If they don't tell us we cannot start collecting it […] we are kulis[21], right, we have to feed our stomach and we go, we get paid that day." (Interview 8, 6.9.2011)

The society was referred to as a "kind of vehicle" (Interview Setty, 10.9.2011), it operated as an intermediary, thus, collected produce always had to be sold to LAMPS. The operating process was internal: first, the board set a price based on the market, and then appointed agents in the *podus* were informed. The people who collected the NTFPs sold it to the agent, who sold it to LAMPS, who then sold it to a tender (Interview Prabhu, 13.9.2011). There were three LAMP societies associated with BRT that annually set prices per kilogramme and adjusted the respective quantities that were accepted by the society. The particular items that were authorised had to be specified in annually renewed agreements between LAMPS and the forest department (Interview Prabhu, 13.9.2011). The number of items decreased from 24, agreed upon in the nineties and early noughties, down to only three items in 2011 that were amla, lichen and honey (Interview Prabhu, 13.9.2011). The 2004 amendment to the Wildlife Protection Act introduced a national ban on

[20] *Society* refers to the cooperative LAMP societies established in India in the 1970s for integrated tribal development in regions with significant tribal populations.

[21] *Kuli* is the Hindi word and has historically been used to refer to an Asian slave or manual labourer. In certain contexts and countries the term is offensively linked to its etymology. In the research setting it was commonly used and referred to manual labour, mostly engaged in construction work.

the collection of any forest products for commercial purposes in all wildlife sanctuaries. The ban was enforced in early 2006 and *"no NTFPs were allowed to be harvested from BRT for three years. The Soligas [living inside and around the sanctuary] had to face a complete lack of income from NTFPs until of course the Forest Rights Act came into force in 2008"* (Interview Rai, 20.7.2011). The decision on a NTFP ban directly impeded the efforts of Soligas to meet their livelihoods ceasing rights to access and utilise forests within the sanctuary boundaries. Mandal et al. 2010 reported that this ban also prevented the community from excercising stewardship of the forest. Dixit Kumar, the Deputy Conservator of Forest (DCF) who was in charge of BRT in 2004 argued that stopping NTFP collection would create suffering and backfire on conservation itself, and basic livelihood activities should be considered *"bona fide"* and not *"commercial"* (Kumar, cited in: Kothari 2007). At the national legislative level, the ban principally persisted, however, the DCF in power gave an oral authorisation in tolerance of particular items with particular periods of time for BRT (pers. Comm. C. Madegwoda, 26.7.2011). However, it appeared that under the regime in place the use and access to forest resources overall had tightened and livelihood collection was subject to control that was increasingly stringent.

> "The forest people say they won't allow to collect lichen, honey this year […] last year they allowed us, that time everybody went when it was the season for it […] they won't allow us, they say it is their forest, 'don't cut the trees, don't take firewood,' they say […] they say 'take it – but hidden from our eyesight' it should not be visible to them, so we bring it hidden." (Interview 6, 30.8.2011)

In this situation of informal *quasi-authorised* utilisation (commercially as well as for subsistence purposes) people have to depend on their creativity and ability to adapt their subsistence activities and strategies. The perception of *our* forest, the question of *whose forest is it* but also if ownership is factually important to be defined also came up in interviews (Interview 14, 15). Against the backdrop of long-enduring utilisation, it is perceived that people would *claim ownership* over *their* forest – deviated from the collected empirical findings. People focussed on the central issues of access, control and forest responsibility rather than expressing assertions of ownership, yet these issues are closely tied. Interestingly this emerging coherence also frames the concept of forest governance itself. The notion of ownership in *common-pool resources* situations is also in the background, while the elements of access,

rights and control are dominant (Ostrom 2005). The quoted statement above (Interview 6) portrays the situational conflict resulting from contestations over access and control, which translates into a situation of unclear institutional practice and creates conditions of insecure utilisation for local *users.* The situation lacks predictability of utilisation and how local *users* devise and adapt their practice alternates. While certain undertakings are immediately undermined and sanctioned by official authorities – for example the cutting of trees, hunting or burning practices – other utilisation practices are *allowed/authorised* and *users* may even qualify as *claimants* (Schlager and Ostrom 1992) – as for example is the case for monitoring of *amla* and other NTFPs. It appeared that the *users* were well informed about this state of affairs and over time were able to find patterns of utilisation and practices with limited countermanding of department authorities. The local specific emergence of these *institutions*, however, is argued in line with the classical institutionalist view and as facilitating coordinative behaviour in the research context (Vatn 2005; Bromley 1992; Scott 1995). Thus, the ways of utilising forests had evolved as undirected adaptations in the face of new circumstances and experiences. They are classified as changing over time, as transported by various carriers and shaped by cultural and historical forces (Scott 1995). This understanding of change and adaption of the institutional system takes place at the level of day-to-day activities – reproducing collective action as well as through formal claims of rights i.e., claims under the Forest Rights Act 2006 that accrue from customary practices. It was interpreted as a constant re-negotiation process.

Significance of Sacred Sites

The forest provided also non-material benefits to the Soliga people in the form of cultural services. People explained that sacred sites and sacred groves were spaces of spiritual und religious importance to them and they visited *"their own places"* on special occasions. When we passed by a huge tree, that I had never really taken notice of one day a man explained that this was one of the sites where puja[22] was done. The tree was decorated with colours and flowers that had faded away. A small area around the tree was cleared from overgrowth regarding which he said:

[22] Puja refers to worship in modern Hinduism, it is performed in any particular setting and is subject to wide variations, based on regional or local custom, individual inclination, and the person's social status and learning (Lochtefeld 2002).

> "[…] to some places we cannot go, they are sacred. We cannot take anything from such places, no firewood, no sticks, we do not take anything from the trees, but that is further away. It is like that from our great grandfathers' time." *(Interview 5, 30.8.2011)*

When I raised the question of when such places were visited, one man stated:

> "There are so many different places where our gods are. Usually I will go once a year […] when someone dies they will put a stone there, and before we collect anything we go to a different place, there we have to do puja […] different people will go to different places, this is why there are different gods." *(Interview 3, 25.8.2011)*

One woman mentioned a temple further down inside the forest, which she visited once or twice a week *"to get/do puja, to invoke god's blessing"* (Interview 6, 30.8.2011) and many other people explained that they would go to their sacred sites especially during religious festivals and occasionally when it was necessary. In 2010, Atree together with the community-based organisation Soliga Abhivrudhi Sanga (SAS) created a map of all sacred sites in BRT wildlife sanctuary. In total there were 489 *sacred sites* mapped, that were divided into *devaru, maramma, habbi, veeru, kallugudi* and *sagga* and each of these cultural spaces were associated with specific clans (Atree 2010b). The map was generated through an extensive consultative process and can be understand as an attempt to recognise the historical and cultural ecologies (Atree 2010b). It is notable that the documenting process can be interpreted as a formal recognition process in support of Soligas historic presence in the landscape, reaffirming local institutions. The map also constituted spatial evidence important for filing claims under the Forest Rights Act 2006, transforming *de facto* entitlements into *de jure* rights. This procedure from recognition by recording and visualisation of cultural geography (Mandal et al. 2010), marks the realisation of institutional inclusion into policy and legislation. Albeit the implementation of the FRA on a government level may not simultaneously ensure the recognition of rights in the fieldwork setting.

Location and User Groups

Many people from *Kalyani podu* were also engaged in farming. The problem of crop damage caused by wild animals was often brought up in conversations and interviews. The fundamental reason that was given was the particular location of the *podu* next to the lake and adjoining to the forest (Interview 4, 6, 9, 10). Wild animals would come to the lake for drinking and because *"the ragi samplings are of much flavour to them, it's like sugarcane in the plain"* (Interview 4, 25.8.2011). The unfenced fields had to be watched during night times after the saplings sprouted. In principal, there existed a legal provision for compensation by the Indian state governments in case of crop loss through wild animals around wildlife sanctuaries and national parks (pers. comm. C. Madegowda, 11.9.2011). However, people from *Kalyani podu* had no knowledge of it or doubted that its claims could become effective. C. Madegowda stated that compensation for crop damage was not common in BRT and as far as he was aware no one ever applied for compensation for damaged harvest caused by wild animals in BRT (pers. comm. C. Madegowda, 11.9.2011). People expounded vividly on the fact that the difficulties owing to the specific geographic site near the lake were the natural occurrence and could not really be avoided (Interview 4, 25.8.2011). In terms of feasible improvement of land and natural resources people expressed that they would need a say, but it would require increased local authority, *"but nobody will allow it, we have no saying in that"* (Interview 15, 14.9.2011). This issue of obtaining benefits, especially provisioning services from the surrounding land is linked to the possibility of decision making over land use and forest use.

> "Yes this is my own land, and over there is my father's land. It is more than enough and it is difficultly for me to fully work on it and finish it […] we need to keep it well maintained then only we will benefit […] if there is excessive work elsewhere I will also do coolie but otherwise I have a department job. I will go there for work and when I am free I work on my land here." (Interview 4, 25.8.2011)

In terms of land ownership claims, this man's statement stood out against the other narrations because of his assertion that he owned the land he cultivated. Despite being aware of the court case, he was certain that he would be granted the land right if he continued to cultivate it. His higher socioeconomic status in terms of income, occupation and also access to land

for cultivation became evident through his statement. Raising the question whether he had goats and sheep and whether he is also engaged in grazing he responded, *"my family has goats and sheep, someone will graze them but I don't go to the forest"* (Interview 4, 25.8.2011). I point out his explanations at length, because of theoretical considerations, dealing with different dimensions of heterogeneities within *user* groups. Thus *institutions* in regard to resource utilisation and corresponding *lived practice(s)* manifest interest that might vary within a *user* group (as well as amongst different *user* groups), and overall should be considered within the broader economic setting in which *institutions* (Vatn 2005) operate. Interests varies with time and priorities on forest utilisation are dynamic and may be open to change. Bose (Interview 25.7.2011) notes that the shift from forest subsistence based economies to non-subsistence economies has to be taken into account, when looking at forest utilisation and questions of forest governance (Interview Bose, 25.7.2011). These considerations are also linked to the question of facilitating conditions for obtaining direct benefits such as provisioning and cultural services and the informed institutions and behaviour towards the forest resource.

Another insight concerning agriculture and forest is the aspect of social stratifications within the people from *Kalyani podu.* The group of *users* is in fact a relatively small and interlinked group, however, people with higher economic and political assets may be marginally lesser affected by, for example, changing patterns of appropriation and use. This *'distribution of interests'* was raised by Ostrom (2005) pointing to the importance of similar impact on appropriators with diverse economic and political assets that would enhance the likelihood of formation of self-governing structures (Ostrom 2005). Generally, it is argued that the group of *users* can hardly be understood as a clearly demarcated homogenous entity, by rational only concerned with maximising their individual utility (Hardin 1968) but people's engagement in forest utilisation may rather be understood as a continuous balancing act. It is understood as a performance of diffusing or bundling interest and behaviour is assumed as thoroughly 'context-rational' (Vatn 2009) instead of 'egoistic-rational.' Following the *classical* idea that *institutions* define which rationality is expected (Vatn 2009) both the communication between *users* and also with other *user groups*[23] as well as the mutual overlooking of *users* activities by themselves is a specific characteristic of the situation. The adaptions and balancing in people's utilisation and ability to obtain benefits has overall been

[23] In the scope of the chapter reference to *users* and *user groups* denotes solely those who reside inside the sanctuary and have entitlements to forest utilisation and not to *users* such as tourists, although both directly interact with the landscape.

linked to the overarching idea of a classification (and conceptualisation) of environmental services as goods, that are subject to an assessment of value (MEA 2005). To some extent, this is incorporated by the external regulatory system of management but is difficult to arrange with the conditions the *users* experience and the expressed views on forest resources.

Community Views on Resource Condition

To what extent people engaged in forest utilisation is also linked to their views on resource conditions, their perception of the causes as well as their opinion on the effects of their practices. Approaching forest interaction in conversations people commonly recalled the particular importance of forest fires and drew a comparison between the way forest and resources were previously sustained and how provision and consistency is perceived now (Interview 1, 3, 7).

> "In my grandfather's time, the forest was very different […] when I was a child I remember it, the area was beautiful. There were so many grasslands for grazing. Forest trees were healthy, plenty of genshu and gedde. But they have stopped forest fires, it is difficult now […] it needs to fully burn, then it grows very well. You have seen there is only lantana, there is nothing now […]. The people who have taken over the forest, the central government, they control it now, and they won't allow anything." (Interview 3, 25.8.2011)

The prohibition of forest fires marked as a decisive point in time, since it delegitimized the traditional property rights structure and finally disabled institutional arrangements that regulated forest interaction. The controlled burning of undergrowth was a traditional management techniques of Soligas in BRT for centuries and has shaped the entire forest system (Rai et al. 2007). Anthropogenic forest fires can have profound implications for forest structure, composition, and functioning at multiple spatial scales (Hiremath and Sundaram 2005) and were used in order to promote growth of grasses for livestock and to sustain and systematically monitor forests [ibid].

> "[…] the government, the forest people told us to stop putting fires […]our people had kept the forest so clean, it was no trouble, we were born and brought up here, we told them we cannot live without the forest.

> We know the best system to keep the forest properly, but that time the government was coming from different places […] the forest became overgrown with lantana, there is nothing that can be done […] even if the government gave us some money and we can clear it, still lantana will come back, the government has spoilt it." *(Interview 13, 13.9.2011)*

In interviews and conversations, people framed the prohibition of forest fires as arbitrary, having far-reaching and irrevocable effects. The argument that the absence of fire caused severe negative impact on the forest condition, especially in terms of lantana overgrowth, was prevailing (Interview 1, 3, 5, 6, 8, 9, 10, 13, 16). Utilisation practices and coordinated behaviour are connected to these personal views.

It was highlighted that the decrease in *amla* (trees and fruits) originates from the infection of mistletoe that is linked to the suppression of fire and now *"the amla trees are slowly dying, there is mistletoe growing on them and without fire the trees will die"* (Interview 8, 6.9.2011). According to the people, the fire regime had also facilitated collection of NTFPs and was expressed to produce fresh grasses as fodder for their livestock and wildlife and enhance growth of medicinal plants and greens and tubers. The traditional fire management system originated from centuries of engagement with the landscape and may be treated as collectively created heritage of context-sensitive knowledge, following its specific institutional logic. The situated perspective on the practice of buring forest areas was that *"forest fires are the medicine for the growth of trees"* (Interview 5, 30.8.2011). Thereby it is important to differentiate between the Soligas controlled burning practice as part of the traditional forest management and wild fires. Ever since the colonial intervention official policies in India have advocated the suppression of fires (ATREE, n.d.). Also in BRT, the Karnataka forest department banned the use of fire after the area was declared a wildlife sanctuary. Thereby the traditional system of management became delegitimised and undermined by being replaced by international protected areas management guidelines. This is argued to also mark the beginning of the confrontation of manifest behaviour that is embodied in conflicting institutional systems.

In BRT the instances of forest fires was very rare at the beginning, however later on some occurences took place (Rist 2009). In March 2007, several incidents of fire took place within BRT and resulted in considerable conflict and tension (ibid.). The forest department suspected the Soliga community to be responsible for the wild fires (in retaliation of the NTFP collection ban one year earlier), while the Soligas denied the accusations and

put forward the lack of preventative measures taken by the forest department (Kalpavriksh 2007). The situation calmed down again and relationship between Soligas and forest department enhanced again and was at the time of the research, generally described as positive (Interview Rai, 20.7.2011, Interview Setty, 10.9.2011, Interview Bose, 25.7.2011). Interestingly it was found that users interacted regularly with local forest department officials, which signals strength in coordination between state and community. As they also participate in workshops together (ATREE 2010a), they communicate and seek solutions that are socially and economically compatible (ibid).

Within the boundaries of BRT wildlife sanctuary, a complex set of social and institutional management arrangements was in place. For example, in regards to the control of forest fires community views challenged the ecological meaningfulness of this management approach. The question of how and where provisions for management *rules* were created becomes important in the context of compliance to rules. Conflicts are translated into practices and also relate to generation of knowledge and institutional logic. The overall problem with *rules* or *formal institutions* that lack context-sensitivity is that they may find little acknowledgement (Ostrom 1995) and may not be interpreted as meaningful by *users* who are the closest to interact with the landscape. As a result, implementation becomes difficult, costly and/or requires disproportionate operating expenses as in expanded oversight and control over the territory and *rule* compliance (ibid). With regard to the question of how institutions emerge, a distinction between self-emerged and designed institutions could be drawn that also vary in their way of acceptation and enforcement. Thus, *rule*s are more likely to be respected by local people if they had a role in creating them (cf. Ostrom 1995:93 - *third design principle*). *Rules* in this context include appropriation, provision and management decisions and are in the BRT setting distinctly determined by the Karnataka forest department. In line with other ethnographic findings (Rai et al. 2007) people from *Kalyani podu* in the interviews unanimously expressed that the unprecedented changes in forest vegetation were linked to the absence of fire. It is interpreted that some people were resigned to the fact that severe implications for their livelihoods existed due to the worsening forest conditions and that the situational impairment of the resource condition will remain (Interview 3, 6, 9). Local and institutional opinions disagree over the appropriate management responses (Rist 2009) also because perceptions on forest conditions and the undesired effects are presumed to vary between *users* and state government. One man explained:

> "It was around 20 to 25 years ago, when there was many more places that we went, but the paths cannot be found, it is not possible to go there now. […] It has changed because the forest has changed, many areas are overgrown, now there is no single way to stop lantana […] I cannot say what has to be done, the government only has to answer that." *(Interview 13, 13.9.2011)*

The invasive species lantana (*Lantana camara*) has also officially been recognized as affecting native biodiversity in BRT and interfering with overall ecosystem functioning (Atree 2012). Rai (Interview 20.7.2011) explains that efforts to control further expansion may not go far enough since the problem is addressed in budgetary fashion rather than ecologically (Interview Rai, 20.7.2011). Atree has undertaken long-term monitoring in BRT for more than a decade and in partnership with the Karnataka forest department the research organisation has examined the native-species restoration options for regeneration (Atree 2012). All stakeholders, including the forest department, the community, VGKK, the civil society seem to become aware that further lantana invasion is problematic (Interview Setty, 10.9.2011). One man voiced his scepticism on the sincerity of the approach to counter the lantana invasion *"they will only clear alongside the road so you won't see that it is all overgrown […] we told them and from Atree they showed them all the tests … I don't know if what the government took from the tests"* (Interview 13, 13.9.2011). Local perceptions on the necessity to control lantana growth were viewed under the aspect of utilisation nevertheless argued benefits are also connected to ecosystem functions and services.

Monitoring and Sanctioning of BRT Forest Resources

The forest department is the state authority which officially controled the BRT forest area and managed according to the provision of the wildlife sanctuary management plan. While direct *users* and department authorities interact at different levels, people raised the issue of experienced control and limitation often in interviews (Interview 2, 6, 8, 13). Encounters took place in direct contact during grazing and collection but also at created platforms for dialogue, such as collaborative workshops (see: commercial utilisation). In direct contact with the forest department employees, people often expressed a limitation in utilisation, in an explanation on why they collected a certain resource or not it says: *"but the forest people won't allow it, they tell that we*

should not go" (Interview 6, 30.8.2011). These relational references suggest that the forest department authorities tolerated access rules only off the record and sanctioned only under certain circumstances. When I asked that woman what would happen when she became visible to forest department officials, she sounded resolute.

> "When they see us with firewood they shout, and untie it and burn it. Now there is someone from our people, he will help us […] he tells them that our people don't understand, 'so you don't trouble them, they are illiterate' he will say." *(Interview 6, 30.8.2011)*

Within every *podu* one or two people were chosen to act as contact persons whenever there were direct conflicts with forest authorities or access problems. In *Kalyani podu,* this person also functioned as LAMPS agent and was politically engaged as a member of the *Panchayat*[24]. Together with a second person they were also, the representatives in the community-based organisation *Soliga Abhivrudhi Sanga* (SAS) under the umbrella organisation of *Zilla Budakattu Girijana Abhivrundhi Sangha* (ZBGAS). At large there are four SAS in Chamarajanagar district involved in activities relating to the rights of tribes, ensuring that government-allocated funds for tribal development are shared 'equitably' among the members of the community (Bawa et al. 2007). Each SAS has 21 members from all *podus* of the respective taluks[25] (pers. comm. C. Madegowda, 20.8.2011) and people from the Soliga community elect their representatives. These representatives were often referred to as tribal leaders and usually were those who participate in workshops, strategic training programmes and who were the first to be informed about changes in legislations or other political events (pers. comm. C. Madegowda 20.8.2011). Community members, who were aware of the on-going efforts, supported SAS as an organisation and their activities. In matters of forest governance SAS takes on the role of social-economic advocacy of forest utilisation and thereby potentially strengthened the perceptibility of the local perspective (ibid).

The ecological monitoring function of the forest department authorities was expressed as the most visible (Interview 3, 6, 8, 12). The forest department was vested with widespread monitoring powers and regularly visited forest areas but also oversaw the dwelling zones.

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[24] A Panchayati raj refers to the village level, the system introduced by constitutional amendment in 1992 functions as a system of governance.

[25] In Karnataka *taluk* is the name for a sub-district, an administrative division that comprises several villages or village clusters.

> "They keep taking rounds in the forest and in the podus, our own people are there, they are called watchers. On their roams this forest people [ref. to forest department] will ask us if we sighted wildlife or if anything obscure was inside the forest, this is how they know." (Interview 8, 6.9.2011)

Practices of forest utilisation brought local *users* daily to various parts of the forest areas, where they took notice of changes, made observations and to some extent monitored forestlands. Overlapping of monitoring was not only physically noticeable, as in direct encounters inside the forest between forest department officials and Soligas but also in complementary observations, for example of poaching or wild forest fires. Anything unusual that was noticed in regards to wildlife or resource conditions was communicated to the forest department authorities when they took their rounds (Interview 1, 5, 8, 14). During fieldwork, there was only one occasion that I observed such an *"inspection,"* I saw a group of six people from the forest department (due to their green uniform easily identified as department authorities) leaving *Kalyani podu* in a single file in the late afternoon. One woman explained that they would come around once a week, they talked to whoever was at home and made enquiries. On that day they came around because of the elephant mother that had roamed around the lake with her offspring during the last few nights. It is argued that, monitoring was in fact to some extent shared between *users* and the forest department whereby supplemented observations were available to department authorities through habitual contact.

Extensive resource monitoring system was found in practice in the case of commercially used resources. Atree facilitated participatory monitoring of local communities and has worked towards improved sustainable harvesting in order to enhance income from NTFPs (Bawa et al. 2007). These participatory approaches to resource monitoring started in BRT from 1994 onwards and were carried out in a more institutionalised manner since 1998 (Rist 2009). Training programmes on sustainable harvesting were conducted on honey, lichen, gooseberry, etc., while communities were also pivotal actors in protecting the forest from wild fires (Interview Setty, 10.9.2011) and thereby perform monitoring and exercise control functions. One man explained that the main problem was that even if low intensity controlled fires were allowed, they still could not be carried out because:

> "the forest trees have all got lantana clinging up them. You cannot save it even with forest fires … now all the big trees will also burn, everything will catch fire and after the burning nothing other than lantana will come back." (Interview 13, 13.9.2011)

When I asked about cases of observed wild forest fires the people's responses were either disputing the occurrence or indistinct. Given the competing claims over forest utilisation it is noteworthy that *users* behave in effect cooperative towards the forest department instead of antagonistic in terms of control of fire and forest protection. The curtailment of their controlled burning tradition is deplored on the one hand but at the same time critically contemplated because of current resource worsening. The prohibition of fire that emerged from the WPLA approach to manage a forest was first adopted by law, enforced through coercion by the authority system and gradually became transformed into a *rule* that was adhered to.

The current regime in BRT hardly provided for people's participation in the designing and planning arrangements of the forest areas. It seemed that in the existing situation the institutions were primarily informed by external regulations and the situation was characterised by facilitating adjustment to regulative systems. Although the management arrangements towards the forest resources was in an institutional sense to some extend multi-layered, because i.e., people also fulfilled monitoring functions and exerted influence, it was inherently problematic as i.e., people's role and effort remained unremunerated.

CONCLUSION

This chapter seeks to illuminate the situational conditions of people's utilisation of forest resources in BRT wildlife sanctuary in 2011. The applied ethnographic approach allowed for critical findings in regards to the complex instiutional arrangements and to understand local *lived practices*. Adopting a classical institutional perspective, the notions of contestation and uncertainty were constitutive.

The current condition under which the forest is accessed, managed and used is influenced by a complex system of customary and traditional *rules* on the one hand and on the other by *formal institutions* embodied in state *regulations* (according to sanctuary management objectives). Results showed that the interlacing of self-organised institutions and designed *rules* defined

any kind of utilisation for the people from *Kalyani podu*. Whereby, the distinction between *institutions* is based on their diverging in emergence and rationale, the respective potential of enforcement and the way in which they become legitimised.

Encounters between various *users* and *user groups* that engaged in utilisation were observed to be relevant in the setting of *Kalyani podu.* Spatial overlap with other *user* groups enabled communication, exchange of news, problem resolution, that was being performed during grazing and collection practices. People's behaviour was found to be cooperative, responsive and coordinated to each other's activities. People's views on resource conditions and the monitoring and sanctioning functions were analysed as these appeared particularly relevant. Choices on forest resources were expressed differently and reviewing individuals' situations allowing for the localisation of interests in the utilisation. Regarding the collection of certain NTFPs the people were *authorised* when tolerated by the forest department. Given that the centrally organised state management in BRT is primarily targeted at biodiversity and wildlife conservation, the utilisation by forest-dwelling people was highly contested. Within this context of situational contestation over particular portions of benefits the situation was also characterized by the unbalanced vesting of power. People expounded on the experienced control and pointed primarily to the prohibition of anthropogenic seasonal burnings that was perceived as severe retrenchment in *managing* the forest in the past.

In *Kalyani podu* the property rights regimes comprised private cultivated lands, state-owned forest areas, collectively used grazing pastures, clan specific sacred groves (protected by spiritual taboos), forest patches for NTFP collection collectively accessed, unclassed surrounding cultivated and uncultivated areas and the public groundwater. The BRT *forest property regime* featured specific historical and cultural circumstances originating from people's continual interaction with the forest landscape. In terms of the concrete resource regime in place, the "old" question of *conservation for whom?* (Googh 1997) had to be scrutinised. It is important to ask who has a stake and who is benefiting from a certain resource regime and on whose behalf it is managed – *its biodiversity value, nations species richness, its citizens, its environmentalists, its tourists, its local communities* – (Googh 1997) or respectively – institutions *designed* for whom? In accordance with the positional analysis in this chapter, these questions were thought along, while looking at forest utilisation and management and its situational contestation.

Guided by the conditions under which people interacted with and utilised the natural resource, the observed practices were contextualised within the classical institutaional perspective. This, in turn, cannot be divorced from the broader idea of social constructivism. It is uttlerly important to recognise the interactive and mutually constitutive character of institutions in relation to behaviour (Vatn 2005). The role of the collective and the effects that institutions have in forming the individual (ibid.) had to be highlighted, when following this, people were depicted as the survivors of the system.

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Chapter 6

LOCAL LEVEL POLICIES FOR TOURISM MANAGEMENT IN PROTECTED AREAS: EXPERIENCES FROM COSTA RICA

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ABSTRACT

In recent times, there has been a significant expansion in protected areas in terms of numbers of areas as well as sizes of areas to meet the challenges of ecological conservation and growth. Hence, creating parks and other types of natural reserves is an issue that demands desperate action in order to ensure the environmental health of the planet. Human activities in relation to natural resources and bio-chemical cycles disturb the sustainability of the earth's surface. Due to these effects, it is necessary to improve policies in protected areas to deal with the deterioration caused by human activities and bio-chemical cycles.

The rationale behind the development of relevant policies is to cater to the need to understand each protected area as a being a part of local development systems. Other policies that have been developed include defining local action and internal management systems such as tourism

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activities. Local policies related to tourism management and getting local people involved in protected areas' management are two important approaches that need to be evaluated in order to identify future challenges in regards to the conservation of protected areas.

This chapter analyzes Costa Rica as a case study for tropical experiences, taking into consideration events of the last 40 years that have established an important number of protected areas covering about 15% of the country's terrestrial surface and the policies that have been implemented for their protection. It evaluates the issue of tourism management and involvement of local people in protected areas as a master plan. Finally, some recommendations are given to reduce the negative effects of tourism in these areas. The chapter also suggests some actions to empower local development in areas surrounding protected areas.

Keywords: ecotourism, local development, communities, Costa Rica

INTRODUCTION

Nowadays, the capitalist system is characterized by the strength of globalized economic relationships that subordinate underdeveloped countries to the capital accumulation of central economies' priorities (Cordero 2006). The system is based on a strategy of efficiency of use of natural resources and simple use of the local labor force. In the last century and in the present era, capitalism has eroded trade barriers in order to allow for expansion of mega-businesses involved in technology, communication, health, agro-business, and tourism. The goals and interests of tourism-based mega-businesses in particular are making incursions into the functions of nation states, which coincides with the vision promoted by neoliberal ideology (Santos 2001).

Such companies overcome national regulations, and create the conditions for very expensive infrastructure provision, such as water services, electricity, airports, ports, and roads, free from the burden of taxation. This causes great changes in local communities by promoting tourism as an economic activity (Buades 2007), without considering the possible negative socio-environmental effects at the local and regional levels. In the current capitalist system, the trend in conservation of protected areas has been shifting from having an ecological goal to being an economic activity (Fletcher and Neves 2012).

In this context, it is necessary to conduct research to identify the kind of relationship that has emerged between protected areas and existing tourism models in order to define new policies to guarantee conservation and local

development. A study by Kwaw et al. (2010) found no evidence that protected areas have exacerbated average rates of poverty in neighboring communities in Costa Rica and Thailand. That research, however, was mainly based on general information and did not consider that many of these buffer zones are inhabited areas, as compared with urban and peri-urban spaces, and that for this reason, poverty is not as high as in those areas.

There is little research that addresses the issue of tourism in protected areas from local and regional perspectives. The majority of studies address only ecotourism (Honey 1999; Wearing and Neil 1999) and do not present deep analyses of the impact of ecotourism on local development and ecological conservation. Studies about local development and tourism do not usually consider protected areas, according to López (2005), who carried out a study in Nicaragua that focused upon destination planning at the local level. In Costa Rica, Furst et al. (2004) conducted research to identify economic benefits in only three national parks, a limitation that prevents generalization of their conclusions.

Costa Rica is very well known as one of the world's leading 'nature destinations.' Despite this, there is no satisfactory information available to identify the relationship between tourism and protected areas (Morera 1999). Accordingly, this chapter analyzes the relationship between tourism and protected areas in Costa Rica. The objective of this chapter is to evaluate the kind of relationship that exists between current tourism models and protected areas in the context of local development and the management of these protected areas.

TOURISM DEVELOPMENT IN COSTA RICA

The economy of Costa Rica has traditionally been based upon agriculture, i.e., coffee, bananas, etc. This has, however, been changing rapidly, particularly after 1993, when tourism became the main source of income for the country. According to Morera (2011), the following national and international factors explain the change:

Increased environmental awareness: The speedy degradation of natural resources that has occurred over the last century has generated increased environmental awareness and enhanced the popularity of natural destinations, mainly in developed countries.

The biodiversity richness of Costa Rica: Visits by renowned natural scientists, attracted by the biodiversity of the country, starting in the eighteenth

century, and extending to the early twentieth century and later, and have helped to build an international image of Costa Rica as a 'nature country.'

Tourism companies looking for new products: The idea of tourism as an economic activity emerged in the early twentieth century and has mainly focused on the resources of the sun and beaches ('sun and sand' tourism). Later, however, there was expansion into new categories such as ecotourism. Costa Rica has emerged as a leading ecotourism destination.

Development of communication: The growth in communication technologies (television, the Internet), and air transportation has aided the development of tourism activity in recent decades.

These factors, combined with others such as Costa Rica's social conditions and absence of a visible army explain the massive growth of the country's tourism industry. Looking at business dynamics and how communities are involved in tourism, Costa Rica's tourism development can be characterized as having passed through four stages (Figure 1).

Exploration (1970-1982): During this period, small- and medium-sized local entrepreneurs dominated the tourism sector. Additionally, relationships between tourists and local social groups were dominated by curiosity and friendship. These conditions are comparable to adaptation of the product-based tourism cycle (Butler 1980) and to the pioneer step, according to the Master Plan for Sustainable Development 2005-2008 (ICT 2012). Government policies determined by the ICT (Costa Rican Institute of Tourism) were insignificant, and the tourism industry was focused on meeting local demand.

War in Central America (1982-1986): The civil wars in Central America during the 1980s caused a setback to the country's tourism activities after the exploration period. During this time, there was a deterioration in flows of international tourists to the region, which affected Costa Rica, even though the country was not directly involved in these conflicts.

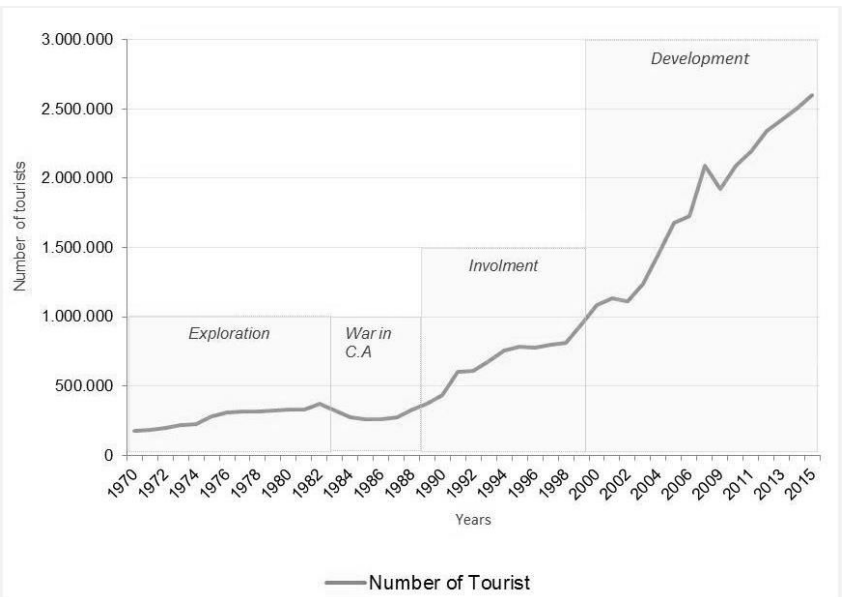
Involvement (1986-1997): During the involvement period, the ICT defined the first stage of growth as being characterized by moderate ecological tourism. In addition, the government's 'set tourism policy incentives' were the major domestic factor that guided tourism activity in the years to come. This period saw accelerated growth of local small businesses and potentiated endogenous development without big tourism companies.

Development (1998-2016): Since 1998, tourism products have been promoted by big tourism companies, which have emphasized various attractions and which have consolidated the 'sun and sand' segment. This period has also witnessed emerging conflicts between the interests of large-scale tourism enterprises and local communities in respect of access to and

management of natural resources. Many local areas have been acquired by international companies. There have been social movements that have arisen in response to conflicts, with people seeking to protect their rights to access water resources and beaches in particular. During this period, there has been increased development by real estate companies, especially aimed at building 'second homes' for people. In 2009, there was a dramatic fall in visitors to Costa Rica as a result of the September 11th terrorism attacks in the United States.

According to the Costa Rica Tourism Institute (2010), the tourism model of Costa Rica will have several challenges in the future to keep building upon and reinforcing growth on the bases of environment factors and attractiveness. Sustainability, biodiversity, culture, and authenticity have been identified as critical factors that are relevant to the historical position and recognition of Costa Rica as a nature tourism destination.

It is also necessary to diversify the product offerings of the country by adding other segments such as rural tourism. It is also necessary to deal with strategic unresolved issues of strategy such as planning and management, and to support and strengthen municipalities and business institutions.



Source: ICT (2016).

Figure 1. Number of tourists in Costa Rica, 1970-2015.

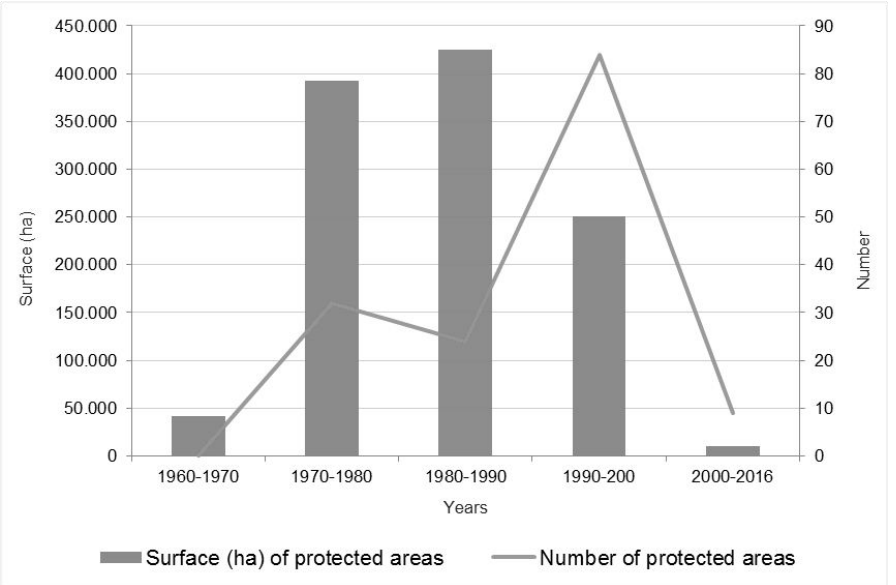
PROTECTED AREAS SYSTEM OF COSTA RICA: BACKGROUND AND CONTEXT

A protected area is a complicated and dynamic system that seeks to achieve a balance between cultural aspects and heritage conservation. A protected area must also be attractive to (e.g., offer amusement to) and provide access opportunities to visitors working with local community groups (IUCN 2014).

Even though each protected area is created for a specific purpose, things can change, depending upon the place and time (Adams 2006). The main 10 attributes of protected areas, according to Eagles and McColl (2002), are: wilderness; community social function; hunting preserve; business and profit; physical and emotional health; ecological preservation; recreation; meaning of life; protecting native people and their lands; and historic and cultural preservation.

The first protected areas that were created in Costa Rica in the 1970s resembled those implemented in the United States, and were based on the principle of preserving ecological resources. There were, however, some isolated initiatives such as the Cabo Blanco Absolute Reserve implemented by Nicolas Wessberg and Karen Morgensen in 1963. Another initiative was the protection of the Poas and Irazu volcanic area and a 2-km corridor on either side of the Inter-American Highway in the Talamanca Range Mountain to preserve the cloudy forest that is dominated by the oak tree (*quercus*) (Vargas 1994). The model applied to protected areas did not consider the socio-cultural values of land, however, and many communities were forced to move away from their lands.

Figure 2 shows the number and the surface areas of protected areas by decade in Costa Rica. Before 1970, there were only three parks with an average surface area of 1,384,070 ha. Between 1970 and 1980, there was a dramatic increase in the development of protected areas (a growth rate of 1066%), with change in the average surface area to 1,242,478 ha. Between 1980 and 1990, the number of conservation units decreased, however, but there was an increase in the average surface area of 30%. Between 1990 and 2000, there was a marked increase in the number of protected areas (an increase of 350%). The period 2000-2016 saw the creation of nine new conservation units, with an average surface area of 113,594 ha.



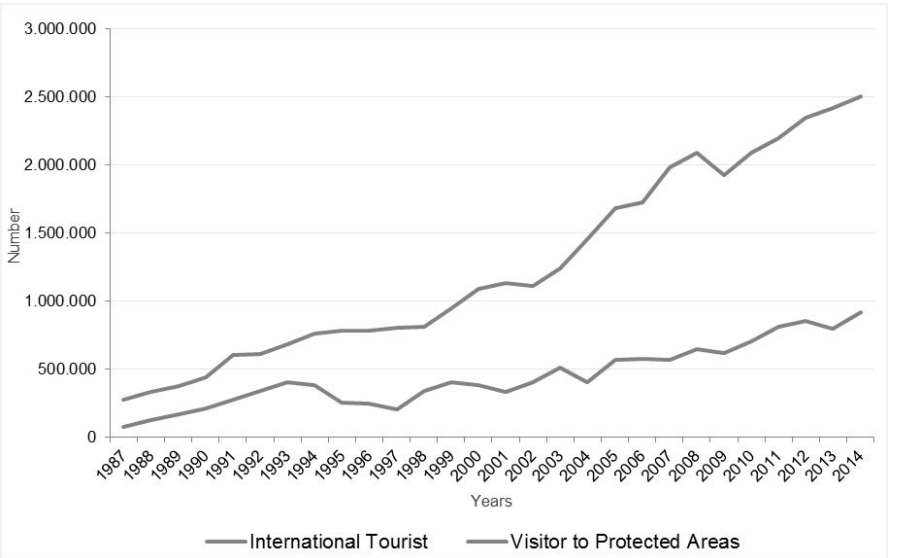
Source: SINAC (2016).

Figure 2. Surface areas and number of protected areas in Costa Rica, 1960-2016.

Establishment of protected areas was an important government policy designed to stop rapid deforestation and the expansion of country's agricultural sector into natural areas. At first, the state issued a declaration pertaining to the largest forest fragments and declared various parks and biological reserves as public land. In the last few years, however, the policy has expanded to regulate wildlife refuges, small pristine ecosystems, and even private land, much of which is now controlled by the government.

RELATIONSHIP BETWEEN PROTECTED AREAS AND TOURISM

The system of protected areas has been and is still a key dimension for tourism development in Costa Rica. Many nations promote nature-based tourism in order to achieve the dual goals of nature conservation and income generation (Hearne and Salinas 2002). This is not the case in Costa Rica, however, because protected areas were established before the tourism boom began, as can be seen in Figures 1 and 2.



Source: SINAC-ICT (2016).

Figure 3. International tourists and visitors to protected areas in Costa Rica, 1987-2014.

In general, natural resources, especially biodiversity, are the main tourist attraction of Costa Rica, although those are not necessarily concentrated in protected areas, but rather are to be found throughout the country.

Because of the country's attractions, the number of tourists who visit Costa Rica increases every year. Rates of growth of visitors to protected areas, however, have been less than levels of growth overall (Figure 3). The gap between these numbers is increasing each year, showing the weak relationship between conservation and the tourism industry in Costa Rica.

The dominant model of tourism has been shifting from small-scale to large-scale business. Many lodging companies have established nature services such as trails in order to reduce expenses associated with protected areas fees. They have done this to increase their profits. This trend has led to economic crises in protected areas. All the income generated by entrance fees to protected areas goes to various government administrative entities, which keeps most of it, and later distributes the remainder among various areas.

Another factor that has exacerbated problems has been that there has been a differentiated fee applied to people who enter protected areas, with higher entry prices being imposed upon foreigners since 2003. Although no study evaluates the impact of this, in some parks, such as to Poas, Irazú, and Manuel

Antonio, there has been rapid growth of visitors. While biodiversity is a significant attraction of Costa Rica, it is not considered to be the only factor relevant to management of protected areas. Biodiversity is something that most big companies in the tourism industry take advantage of, but that they do not pay for. For a very long time, they have in fact received tax exemptions. For example, in the Arenal Volcano Park, the main attraction of which is the unique geomorphological structure, most tourists and even the owner of the tourist lodge can enjoy it without paying any fees whatsoever.

Another problematic instance has been Tortuguero National Park, which is mainly visited by tourists to watch turtles; only 10% of the nest area on the beach is inside the park boundaries (Jacobson and Figueroa 1994). The situation in this park forced the government to take action by implementing a law that ensures that visitors must pay an entrance fee to get to the nesting areas.

In recent years, there have emerged conflicts between tourism businesses and local communities, such as occurred in relation to water supply in Guanacaste. The problem has been that the dominant tourism model tends to support big companies and allow them to erode local access to natural resources and to use such resources without having to do anything to aid in their preservation.

These big companies are forging a path over all the developing world, and developing countries find that if they decide to change the rules applying to such companies, all that happens is that these companies move to another country. For this reason, Costa Rica has recently given consideration to levying a special tourism tax designed to support protected areas.

A well-managed approach to tourism can bring many benefits to protected areas, visitors, local communities, and society in general. These benefits include: environmental benefits; socio-cultural and economic benefits; political and financial support; generation of income for the protection of nature; improved opportunities for local economic development; enhancements to infrastructure; greater employment opportunities; strengthening of local identity; and improved relations and trust between all sectors (Buckley 2012; ECEAT and EUROPARC 2012; Fennel and Dowling 2003;). Given the widespread potential benefits of tourism in protected areas, some consider it as a panacea, an always ‘win-win’ relationship, and an obvious solution to the problems of developing countries.

A more detailed analysis, however, shows a more complex reality, with such changes creating social movements and conflicts between those who

control the land and those who have other interests in scarce and valuable resources (Honey 1999).

It is in countries that have more protected areas than other countries that one sees the greatest numbers of visitors. However, in the case of parks and reserves that have already been established, it tends to be the case that governments are not willing or able to pay the maintenance costs. Worldwide, there is less and less money available to finance these protected areas.

Many governments plan to use the ticket money (entrance fees) to pay for park management, consolidate infrastructure, and undertake protection, but this self-financing mechanism has not had the success expected, so many countries are now actively calling for private investment to help manage these areas (Mastney 2003).

The relationship between tourism and protected areas is complex and tourism is a critical component to consider in the establishment and management of protected areas (Eagles et al. 2002).

TOURISM MANAGEMENT IN PROTECTED AREAS

According to Evans (1999), since the creation of the first national parks, tourism, recreation, and research have been important elements to consider. Nevertheless, until now, reasons related to ecological considerations have been the main factors in management considerations.

In Costa Rica, there are some parks/protected areas, such as Poas, Irazú, Manuel Antonio, and Cahuita, that see the highest levels of concentration of visitors. There are others, such as Barbilla, Diria, La Amistad, Los Quetzales, La Cangreja, and Piedras Blancas, where visitor turnover is very low in comparison. Therefore, Costa Rica has an overcrowding problem for some parks, a problem that may be solved through amendments in entrance fee changes.

According to Chase et al. (1998), the way to solve the problem of different concentrations of visitors to various protected areas in Costa Rica is by reducing the fees to low-visitation parks and by increasing them in high-visitation parks, but the government has yet to implement this strategy. Such a strategy could be designed so as to increase numbers of visitors to low-visitation areas and thereby better protect high-visitation areas.

An examination of government policies shows that the dimensions of recreation and tourism are not considered as strong as necessary in protected areas' management. For example, in the master plan for Corcovado National

Park, there are some recreational elements, which are based on trails, which will be used mainly for park rangers (Vaughan 1981). This vision applies today.

The current official guide that sets out how to carry out a master plan for protected areas is based on activities inside the borders of such areas, recreation, and tourism; local communities' participation is not considered as a key component (SINAC 2013). There are only few parks (e.g., Santa Rosa) with a program to address eco-tourism demand, and in the majority of the protected areas, there are not enough employees to attend to visitors, nor are there even adequate facilities for such visitors.

There have been, however, some initiatives to transform the situation. For example, there is one project called Trail of Osa (Caminos de Osa) in the Osa Peninsula that has combined the goals of non-governmental, governmental, and international agencies to develop a local tourism product by creating routes surrounding Corcovado National Park in order to support local development. As noted earlier, the Costa Rican economy has been changing during the last few years, moving from agriculture to services. For this reason, it is necessary to look for new income sources among local communities. For most communities living next to protected areas, however, they do not perceive tourism as an economic opportunity.

Mora and Chavez (2015), for example, found that most of the people living in the Paso Llano and Sacramento communities, located in the buffer zone of the Braulio Carrillo, have migrated abroad to look for jobs and also found that about 50% of the houses in these communities have transformed into second homes.

Over 20 years ago, these protected areas were a part of Costa Rica's tourism products, and it remains a recurring issue that a matter of concern is the need for further progress. Based on this concern, the Tourism Program in Protected Areas (2012-2016) has been implemented with support from the Inter-American Development Bank. This program involves commitment and responsibility to improve tourism management as a main objective to strengthen tourism in the protected areas as a tool to strengthen sustainable management, contributing to local socio-economic development and conservation of natural resources.

Specific objectives are to achieve greater income and financial sustainability for SINAC (National System of Conservation Areas), socio-economic and environmental benefits in municipalities and communities in neighboring protected areas, and institutional strengthening of SINAC for sustainable tourism management (SINAC 2013).

Mainly, the proposed actions benefit only the most highly visited selected areas, and unfortunately only six (Poas, Manuel Antonio, Irazu, Cahuita, Santa Rosa, and Tortuguero) out of the 39 protected areas are considered to have tourism potential, and receive 86% of all visitors.

The key to achieving sustainable development of tourism in protected areas is to go through the planning and management of the activity for each area and to follow a national, coordinated program with other agents. It is also necessary to track the management processes by way of in-depth knowledge of the values of protected areas and how they are changing and adapting to new management strategies (CRC 2008).

Park managers often focus on daily priorities, but they must have a long-term vision. There is little capacity for tourism management in protected areas and there is also poor coordination between the ICT, SINAC, the private sector, communities, and municipalities. This leads to missed opportunities that tourism can present for conservation and development.

TOURISM AND PROTECTED AREAS: THE LOCAL DEVELOPMENT CONTEXT

According to the World Database on Protected Areas, in 2014, 56.8% of the world's protected areas were under government management, while protected areas controlled by indigenous populations and local communities represented only 5.9% and 4.6% of the total, respectively (UNEP 2014).

In Costa Rica, only 13 protected areas have been identified as being managed by local people and these tend to have low numbers of visitors (SINAC 2012). Despite this, in recent years, the government has been carrying out some actions to promote local participation in protected area management.

In the Executive Committee of each official Conservation Area, there is room for members of local communities. SINAC has been transferring management of some visitor facilities to local organizations in order to improve local social conditions.

For example, in the Chirripo National Park, management of visitors' transportation, baggage handling, and food supplies have been assigned to the local community organization. In the Corcovado National Park, there is a new requirement that hikes should be led by a local guide. In addition, in the Cahuita National Parks, there is a requirement for co-management (participation of local communities in the park management) that is a different

way of linking protection and local communities. Nevertheless, there has been slow process, and there are some limits to changes because Costa Rican law does not allow for private participation in protected areas.

Somarriba and Gunnarsdotter (2012) found, in a study in Nicaragua, that the communities there benefited from ecotourism, but not sufficiently, which is similar to what has happened in Costa Rica. The profits generated by tourism do not usually go straight to local communities.

While there has been some action to improve local communities' business capacities, they are still not good enough to be competitive in the national tourism industry. There have been some attempts to integrate local communities in management of protected areas, but these policies are still relatively isolated. After more than 40 years without participation of communities in protected areas management, it is proving difficult to effect change.

Montverde is an instance in which a private protected area has tried to capitalize upon impulse tourism in a 'gate town'. The problem for this area, however, is that most of the facilities belong to foreign-owned businesses, even though they are not big companies. As Nunkoo (2015) indicates, local communities should feel empowered in tourism management, should be knowledgeable about the sector, and should derive for themselves benefits from its development.

The Costa Rican government shares the vision that tourism can provide many benefits such as employment and business opportunities for disadvantaged groups, women, young people, and ethnic minorities by having a diversified supply chain (Ndivo and Cantoni 2016). The relative emphasis placed upon improving the business capabilities of local communities is changing, but actions taken have not yet been good enough to affect the domination of the tourism industry by big, foreign companies.

CONCLUSION

Costa Rica is a good example of the unique way that tourism can support conservation in protected areas if local communities reap economic benefits. There are some positive steps that can be taken to strengthen the relationship between protected area managers and local communities, but it is necessary to generate tourism products that involve local services surrounding buffer zones near protected areas.

We are living in an era of continuous changes, and this affects management of and objectives for protected areas. Costa Rica, where protected areas have been a key dimension for the development of tourism, is no exception. In this country, however, most protected areas were declared as such and were considered by government long before the tourism boom began. In recent years, even though there has an overall rise in numbers of international tourists to protected areas, there have been different rates of growth of visitors to different areas. Currently, the focus of management is on the protected areas themselves, but it is an urgent priority for government to realize that action should be taken in relation to peripheral areas as well, such as buffer areas, biological corridors, and gate communities, in order to integrate local people into conservation efforts, and to increase the benefits they derive from such efforts.

Some steps have already been taken, but these are isolated actions, and it is necessary to change the view that local communities should only reap benefits by way of offering their labor force. Addressing this issue is an initiative that needs to be taken by leaders of SINAC with the support of private and governmental agencies. This would be a new way to promote tourism development without succumbing to the priorities of global tourism companies.

Costa Rica has been a frontrunner in global conservation efforts, but it also needs to provide examples of different ways of doing things that other countries can replicate within their borders. One of these examples is conservation that directly benefits local people and not just big companies, which exploit the attractions of the country's protected areas without paying adequate remuneration.

Finally, Costa Rica has to make sure that emphasis is placed on nature conservation, plural management, equal distribution of costs and benefits, and participation of all agents who might be affected, and it should also conduct further research in order to understand reasons for various failures and successes (UNEP and WCMC 2014).

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Chapter 7

FOREST PROTECTED AREA SYSTEMS AND BIODIVERSITY CONSERVATION IN BANGLADESH

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ABSTRACT

Despite of being an exceptionally biodiversity rich country, the forest coverage of Bangladesh is declining at an alarming rate. Declaration and

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management of protected areas in this regard is one of the efforts from government side to tackle the loss of biodiversity. The limited numbers of forest-protected areas (FPA), established to conserve the dwindling forest biodiversity of the country with high pressure on them for timber, non-timber forest products, and fuelwood - makes their management challenging. Moreover, most of the FPAs of the country declared only in the recent decades with very limited infrastructure, manpower and policy support for monitoring and governance. Some people-centred approaches for the management of FPAs and alternative livelihood and income generation subsidies although made available through a few project interventions, their number are still inadequate and performance remains less than satisfactory. This chapter provides a critical review of the FPAs of Bangladesh looking at their role in biodiversity conservation, management challenges, and key lessons from previous management interventions with recommendations for the future. It has been revealed that the FPA system of Bangladesh still poorly represents the diverse forest ecosystems with relatively small forest size and lack of corridors for the movement of wildlife. There are ample opportunities to render co-management of FPAs an effective strategy to minimize the conflicts in FPAs management in the country. It is, however, important to ensure the access of local forest-dependent people to different alternative income generating options that may adequately support their livelihoods.

Keywords: biodiversity conservation, livelihood, co-management, stakeholder, law enforcement

INTRODUCTION

Tropical forests are the home to about 70 percent of the world's plants and animals and are important for providing critical ecosystem goods and services (Gardner et al. 2009; Laurance 2007). More than 500 million people live in tropical forests and are somehow dependent on it for their livelihood (Byron and Arnold 1999). Despite the significant role of tropical forests in people's life and environment, deforestation rates are high in the tropical region resulting in a rapid loss of biodiversity and wild habitats (Geist and Lambin 2002). Tropical deforestation is also one of the main sources of greenhouse gas emission (GHG), accounting for almost 20 percent of the total anthropogenic GHG emission and a major contributor to global warming (Baccini et al. 2012; Houghton 2012).

Establishment of protected area (PA) is one of the key global strategies that aimed to reverse tropical forests and biodiversity loss (Geldmann et al.

2013; Laurance et al. 2012; Andam et al. 2008; DeFries et al. 2007). Globally, PA networks are expanding rapidly and they now cover nearly 15% of the earth's surface (UNEP-WCMC 2016; Geldmann et al. 2015). Ideally, PA systems are designed to restrict or reduce the anthropogenic pressures in areas of high biological diversity (Venter et al. 2014; Watson et al. 2014; Saout et al. 2013). Other than their key role as a refuge of declining level of forests and biodiversity they are also efficient in providing important ecosystem services like climate regulation, groundwater recharge, erosion control, pollination, etc. (Gray et al. 2016; Beaudrot et al. 2016; Sohel et al. 2015; Mukul 2014).

In many parts of the tropics, only by establishing PAs, however, does not bring the desired conservation outcome making the PAs system ineffective (Geldmann et al. 2015, 2013; Clark et al. 2013). This is largely due to the exclusion of local people in PA governance and absence of alternative income generation opportunities to people who have traditionally been dependent on forests for sustaining their livelihoods (Mukul et al. 2016, 2014, 2012a). Further to that, land-use change around PAs, agricultural expansion, illegal logging, fuelwood, and fodder collection making many PAs vulnerable particularly in the developing tropics (Mondal and Nagendra 2011; Karanth and DeFries 2010; DeFries et al. 2007; Ervin 2003).

Bangladesh, despite being exceptionally endowed with rich biological resources, has one of the lowest per capita forest lands in the world (Mukul and Quazi 2009). The country has also experienced one of the highest rates of deforestation in south Asia (Poffenberger 2000). High population density, rich biological diversity, limited forest cover and rural people's dependence on forests are some of the major challenges of biodiversity conservation in Bangladesh (Mukul et al. 2012a).

Here we provide an overview of the forest protected area (FPA) systems of Bangladesh. The chapter begins with describing the current situation of forests and biodiversity in Bangladesh followed by the status and coverage of existing FPAs and their historical perspectives. We then discuss the present management of FPAs in the country, threats to FPA's and their management challenges. We finally provide some recommendations and guidelines for better management of FPA's in Bangladesh. Our study builds on the experiences and outcomes of the previous study of Mukul et al. (2008) by providing more updated information and analysis. We also reviewed relevant recent literature covering various aspects of FPA's management in Bangladesh. We believe that our study is important for the diverse stakeholders dealing with forests and protected areas management and biodiversity conservation in the country.

FOREST ECOSYSTEMS AND BIODIVERSITY OF BANGLADESH

Bangladesh has a total forest area of about 2.6 million hectares, of which 1.52 million hectares are managed by the country's Forest Department (FD) (Mukul et al. 2014a). Table 1 below shows the major forest types of Bangladesh with their share to country's forest land managed by the FD and total land area. Hill forests comprise majority of the country's forests area, followed by mangrove forests and plain land sal (*Shorea robusta*) forests (Khan et al. 2007). Hill forests are located in the eastern part of the country, evergreen to semi-evergreen in nature and dominated by dipterocarps (Figure 1). The mangrove forests of the Sundarbans and mangrove plantations are located mainly in the southern coastal part of the country. The dominant species here are sundri (*Heritiers fomes*), gewa (*Excoecaria agallocha*), goran (*Ceriops decandra*) and keora (*Sonneratia apetala*) (Mukhopadhyay et al. 2015). The majority of the hill and Sal forests in the country, however, are severely degraded and is without any true vegetation cover (Rahman et al. 2009).

Table 1. Forests areas under the jurisdiction of Bangladesh Forest Department

Forest type	Area (million hectare)	Percentage (%)	
		# country's forest area	# country's land area
Hill forests	0.67	44.1	4.5
Mangrove forests	0.60	39.6	4.1
Mangrove plantation	0.13	8.5	0.9
Sal forests	0.12	7. 9	0.8
Total	1.52	100	10.3

Approximately 5,700 angiosperm species, 29 orchids, 3 gymnosperms and 1,700 pteridophytes have recorded from Bangladesh (Firoz et al. 2004). About 2,260 plant species have so far been reported alone from the Chittagong Hill Tracts region, which falls within the greater Indo-Burma biodiversity hotspot (MoEF 1993). Similarly, the country also possesses rich wildlife diversity. At least 138 mammal species, 566 species of birds, 167 reptiles and 49 amphibian species are available in Bangladesh (Table 2; IUCN 2015). The distribution of major wildlife across the different forest types of Bangadesh is unvenely

distributed (Figure 1). The Sundarbans is the world's largest mangrove forest with the largest remaining habitats of Bengal tiger (*Panthera tigris*) in the world. The Sundarbans is also home to around 334 species of plants, 49 mammals, 59 reptiles, 8 amphibians and 315 species of bird in the country (Aziz and Paul 2015). The hill forests and Sal forests bordering the neighboring India and Myanmar is the home of Asian elephant (*Elephas maximus*) - the largest terrestrial animal in Asia (Alamgir et al. 2015). These forests are also very rich in avifaunal diversity. Several endangered primate species including the western hoolock gibbon (*Hoolock hoolock*) are also common here. Patchy vegetation and lack of corridors, however, making these forest ecosystems unfavorable for country's remaining wildlife.

In the country, a large number of wildlife species are currently threatened with extinction (Table 2). Already, 19 species of birds, 11 species of mammals and one reptile species went extinct from the country (IUCN 2015). In addition, Bangladesh National Herbarium identified 106 vascular plant species with risks of various degrees of extinction (Khan et al. 2001).

Table 2. Present status of inland and resident vertebrates in Bangladesh

Group	Total no. of species	Extinct	Threatened			
			Critically endangered	Endangered	Vulnerable	Total
Amphibians	49	0	2	3	5	10
Reptiles	167	1	17	10	11	39
Birds	566	19	10	12	17	58
Mammals	138	11	17	12	9	49
Total	920	31	46	37	42	156

Source: IUCN (2015).

FOREST PROTECTED AREAS OF BANGLADESH

The history of forest protected areas in Bangladesh is rather recent, started only in 1980's (Chowdhury and Koike 2010). Currently, there are 34 FPAs covering nearly 0.27 million hectares of forests land managed by country's FD (Table 3). This estimate, however, excludes 4 marine and coastal protected areas that were aimed at protecting the marine and/or aquatic biodiversity of the country. The FPAs of the country represents 17.5% of Bangladesh's forest lands and approximately 1.8% of country's total land area. These figures are below the global standard of FPA coverage.

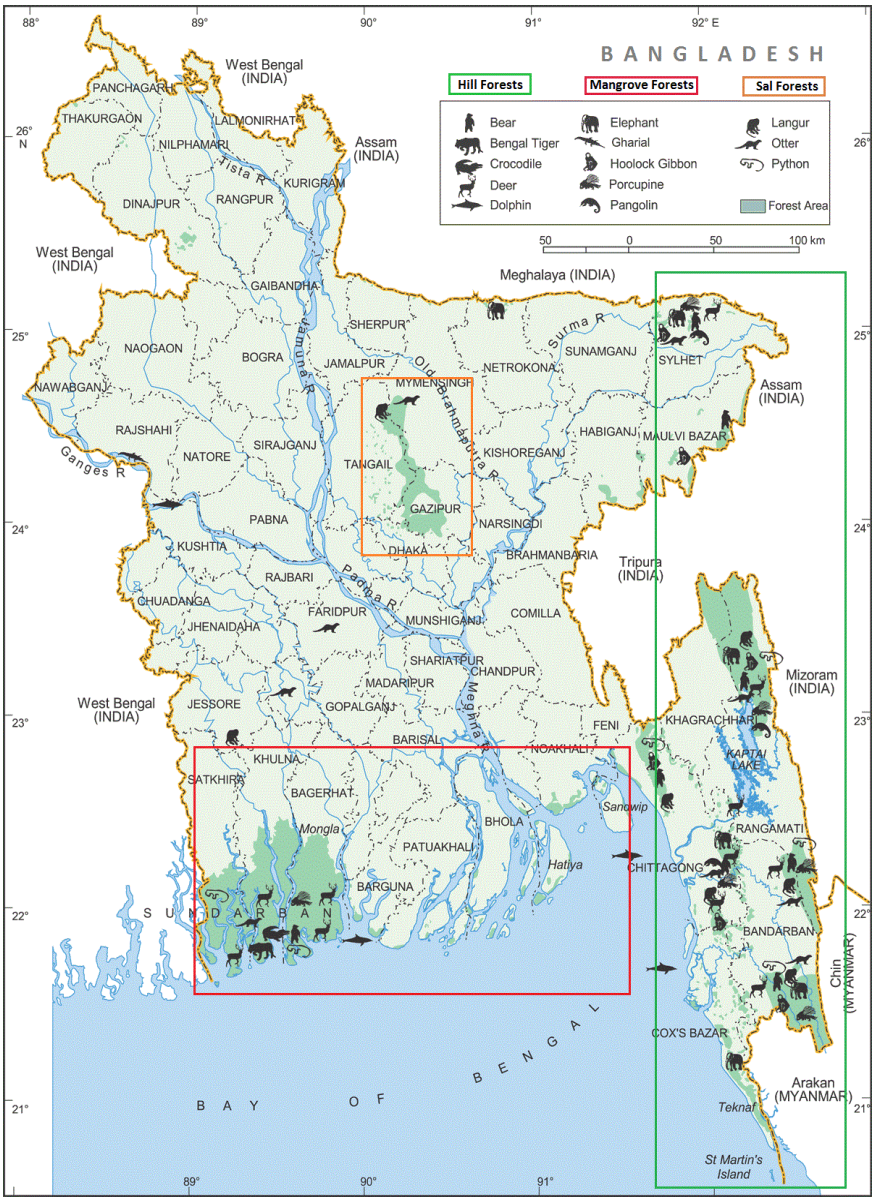


Figure 1. Major forest types of Bangladesh with location specific wildlives.

Most of the FPAs of Bangladesh established only during the recent decade. Figure 2 and 3 shows the temporal changes in FPA's in country in terms of their number and coverage. About 55% of the FPAs of the country started their journey only in the present decade. This is largely due to growing focus and consensus on conservation in the country. In terms of coverage, there has been a large increase in FPA between 1996-2000 although it was due to the deceleration of three wildlife sanctuaries in the Sundarbans mangrove forests of Bangladesh. Among the existing forest protected areas, 17 are national parks and 17 are wildlife sanctuaries, representing respectively 17% and 83% of the total area under the FPA's system in the country.

Figure 4 illustrates the current area under FPAs in different forest types of Bangladesh. About 24.1% of the mangrove forests are under FPA's network, while it is only 12.8% in case of the hill forests. The Sal forests although highly degraded in nature, poorly represented by country's FPA networks accounting only 12.6%. The spatial distribution of FPAs of the country is shown in Figure 5. Many of the FPA's are located in areas that area away from major forest areas needing immediate conservation. Moreover, the size of the many FPA's is very small and inadequate to support the existing wildlife population. For instance, the size of both Ramsagar National Park and Char Kukri-Mukri Wildlife Sanctuary is less than 50 ha.

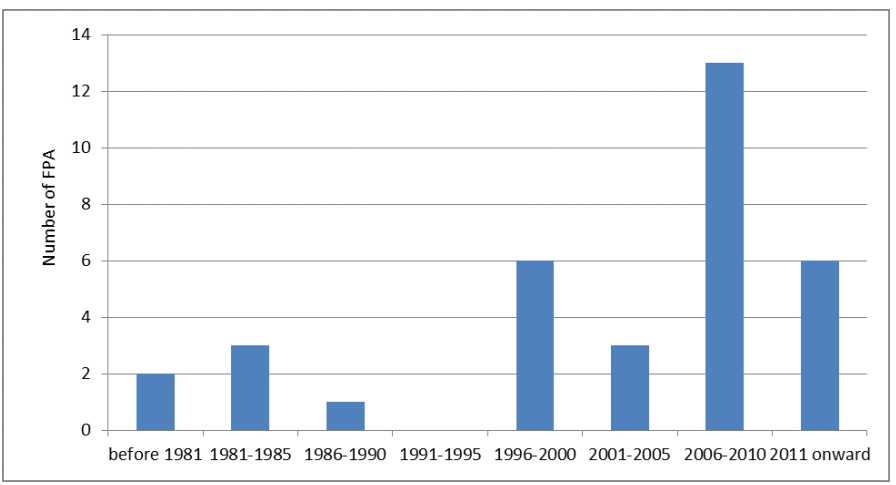


Figure 2. Temporal changes in the number of forests protected areas of Bangladesh.

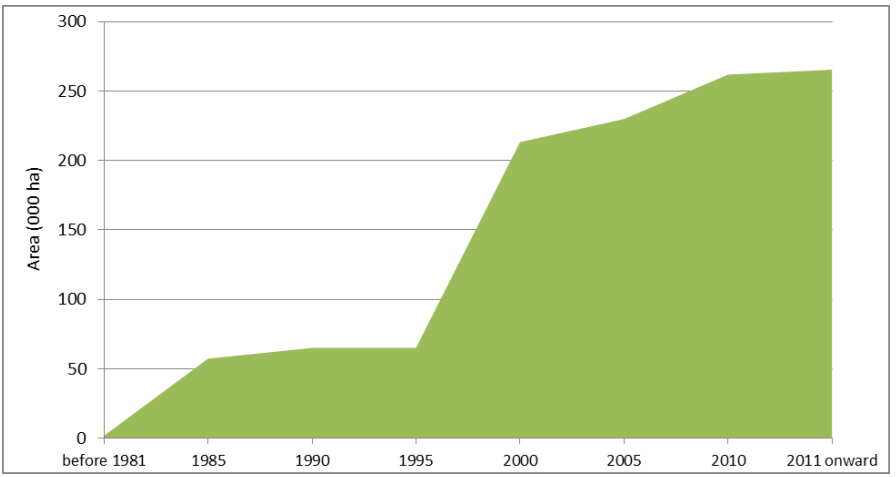


Figure 3. Temporal changes in forests protected area coverage of Bangladesh.

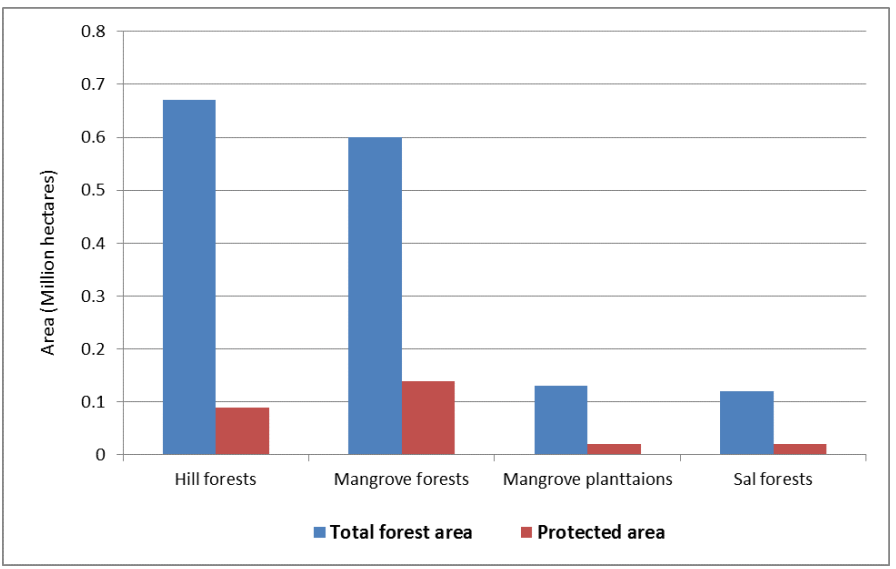
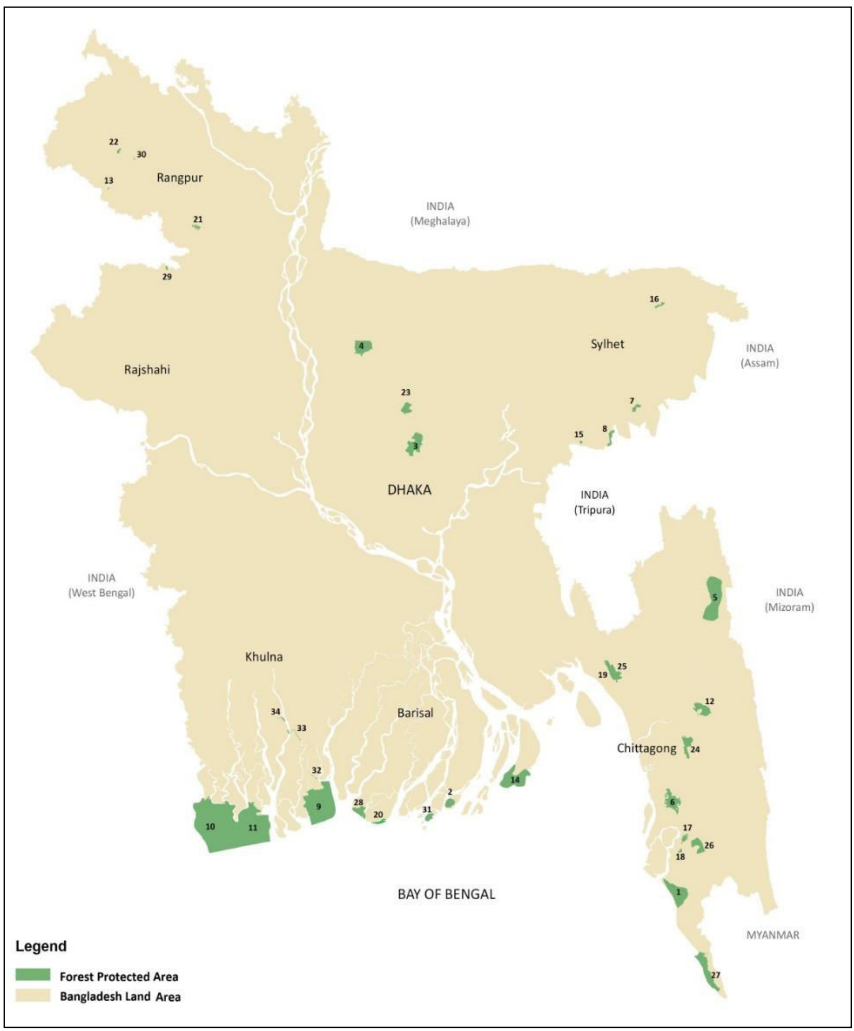


Figure 4. Representation of various forest ecosystems by protected areas in Bangladesh.

Table 3. Details of the forest protected areas of Bangladesh*

Sl no.	Name‡	Year of establishment	Area (ha)	IUCN category	Forest type
1	Himchari NP	1980	1729	IV	Hill forest
2	Char Kukri-Mukri WS	1981	40	IV	Mangrove plantation
3	Bhawal NP	1982	5022	IV	Plain land
4	Madhupur NP	1982	8436	IV	Plain land
5	Pablakhali WS	1983	42087	II	Hill forest
6	Chunati WS	1986	7763.9	IV	Hill forest
7	Lawachara NP	1996	1250	II	Hill forest
8	Rema-Kalenga WS	1996	1795.5	II	Hill forest
9	Sundarban (East) WS	1996	31226.9	Ib	Mangrove
10	Sundarban (West) WS	1996	71502.1	Ib	Mangrove
11	Sundarban (South) WS	1996	36970.5	Ib	Mangrove
12	Kaptai NP	1999	5464	II	Hill forest
13	Ramsagar NP	2001	27.7	IV	Plain land
14	Nijhum Dweep NP	2001	16352.2	II	Mangrove plantation
15	Satchari NP	2005	242.9	II	Hill forest
16	Khadimnagar NP	2006	678.8	IV	Hill forest
17	Fashiakhali WS	2007	1302.4	IV	Hill forest
18	Medhakachhapia NP	2008	395.9	IV	Hill forest
19	Baraiyadhala NP	2010	2933.6	II	Hill forest
20	Kuakata NP	2010	1613	II	Mangrove plantation
21	Nababganj NP	2010	517.6	IV	Plain land
22	Singra NP	2010	305.7	IV	Plain land
23	Kadigarh NP	2010	344.1	IV	Plain land
24	Dudhpukuria-Dhopachari WS	2010	4716.6	IV	Hill forest
25	Hazarikhil WS	2010	1177.5	II	Hill forest
26	Sangu WS	2010	2331.9	II	Hill forest
27	Teknaf WS	2010	11615	IV	Hill forest
28	Tengragiri WS	2010	4048.6	II	Mangrove
29	Altadighi NP	2011	264.1	IV	Plain land
30	Birganj NP	2011	168. 6	IV	Plain land
31	Sonarchar WS	2011	2026.5	II	Mangrove plantation
32	Dudhmukhi WS	2012	170	II	Mangrove
33	Chandpai WS	2012	560	II	Mangrove
34	Dhangmari WS	2012	340	II	Mangrove

* Excluding the three dolphin sanctuaries (Nazirganj, Silanda-Nagdemra and Nagarbari-Mohonganh) and one marine protected area (Swatch of No Ground); ‡ where, NP – National Park; WS – Wildlife Sanctuary.



Where: 1–Himchari NP, 2–Char Kukri-Mukri WS, 3–Bhawal NP, 4–Madhupur NP, 5–Pablakhali WS, 6–Chunati WS, 7–Lawachara NP, 8–Rema-Kalenga WS, 9–Sundarban (East) WS, 10–Sundarban (West) WS, 11–Sundarban (South) WS, 12–Kaptai NP, 13–Ramsagar NP, 14–Nijhum Dweep NP, 15–Satchari NP, 16–Khadimnagar NP, 17–Fashiakhali WS, 18–Medhakachhapia NP, 19–Baraiyadhala NP, 20–Kuakata NP, 21–Nababganj NP, 22–Singra NP, 23–Kadigarh NP, 24–Dudhpukuria-Dhopachari WS, 25–Hazarikhil WS, 26–Sangu WS, 27–Teknaf WS, 28–Tengragiri WS, 29–Altadighi NP, 30–Birganj NP, 31–Sonarchar WS, 32–Dudhmukhi WS, 33–Chandpai WS, 34–Dhangmari WS.

Figure 5. Location map of the forest protected areas of Bangladesh.

MANAGEMENT OF THE FOREST PROTECTED AREAS

Bangladesh Forest Department is responsible for the management of country's forest protected areas. Purely ecological focus and exclusion of local forest-dependent people from the management of the FPAs, however, has been one of the major issues in the country (Mukul et al. 2012a). Poor recognition of local and indigenous people's traditional forests rights and practices has in many cases led conflicts and mistrust between forests protected area managers and local forest users (Mukul 2008). In recent years, some people-centred approaches commonly known as co-management have been promoted in several FPA of the country. The aim of co-management is to improve the management effectiveness of FPAs by involving local people in its governance. Apart from enabling active participation of people in FPAs governance, co-management also offers some direct and indirect benefits to the local people that help to sustain their livelihoods (Rashid et al. 2013a; Chowdhury et al. 2014a, 2009; Uddin et al. 2007).

The co-management was initiated in 2003 in five pilot forest protected areas (i.e., Lawachara National Park, Satchari National Park, Rema-Kalenga Wildlife Sanctuary, Chunati Wildlife Sanctuary and Teknaf Wildlife Sanctuary) through an initiative called Nishorgo Support Project (NSP), with active support from the USAID. This project was further scaled up as Integrated Protected Area Co-management (IPAC) and currently functioning under the project called Climate-Resilient Ecosystems and Livelihoods (CREL) (Rashid et al. 2013b). These projects provided local communities access to different alternative income generating options and livelihood support in order to reduce pressure on adjacent forest protected areas. These supports included but not limited to training and microcredit for nursery raising, poultry and cattle rearing, small enterprise development, training for ecotour guide, etc. (Mukul et al. 2012a). Livelihood supports includes buffer zone management, support for improved cooking stove for domestic use, etc. In certain cases, local community members were also engaged in forest patrolling. These initiatives, although very limited in terms of support and beneficiaries, substantially reduce the local dependency on forests and illegal forest activities like illegal logging (Mukul et al. 2014b, 2012a).

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Figure 6. Some threats to forest protected areas of the country: a) road network within the national park, b) illegal logging, c) invasive alien species and d) NTFPs collection from inside the national park.

THREATS TO FOREST PROTECTED AREAS

The major challenges and/or threats to forest protected areas in Bangladesh are being listed in Table 4. Like other South Asian countries, the high population density creates immense pressure on country's forest protected areas (Clark et al. 2013). A large number of people in the country live near or within the FPAs and largely depends on various forests products. Land encroachment for settlements and agriculture is is also quite common and one of the direct threats imposed by the growing population (Masum et al. 2016; Rahman et al. 2016; Sohel et al. 2015; Islam and Sato 2012). The high requirement of firewood for domestic cooking also causing forests degradation in country's FPAs (Chowdhury et al. 2014b; Uddin and Mukul 2007). Illegal logging, hunting of wild animals for dietary consumption, wildlife poaching, and collection of non-timber forest products (NTFPs) are some other threats to FPAs of the country (Mukul et al. 2016, 2014b, 2010; Chowdhury et al.

2014b; Islam and Sato 2012; Khan et al. 2009) (Figure 6). Climate change and resulting sea level rise, alien invasive species, unplanned ecotourism, road networks within the forests are some indirect threats to FPA's of the country (Alamgir et al. 2015; Mukhopadhyay et al. 2015; Uddin et al. 2013; Rana et al. 2010; Biswas et al. 2007; Mukul et al. 2006).

Table 4. Major challenges and threats to forest protected areas of Bangladesh

Threat/Challenge	Severity	Source(s)
Agriculture	High	Sohel et al. (2015); Islam and Sato (2012)
Alien invasive species	High	Uddin et al. (2013); Biswas et al. (2007); Mukul et al. (2006)
Climate change/sea level rise	Moderate	Alamgir et al. (2015); Mukhopadhyay et al. (2015); Loucks et al. (2010)
Firewood collection	High	Chowdhury et al. (2014b); Uddin and Mukul (2007)
Human settlement	High	Islam and Sato (2012); Rahman et al. (2010)
Hunting	Moderate	Chowdhury et al. (2014b); Sarker and Røskaft (2011)
Illegal logging	High	Mukul et al. (2014b); Islam and Sato (2012)
Isolation/fragmentation	Moderate	Pavel et al. (2016)
Land encroachment	Moderate	Masum et al. (2016)
NTFPs collection	High	Mukul et al. (2016, 2010); Khan et al. (2009)
Road networks	Moderate	Chowdhury et al. (2014b)
Unplanned ecotourism	Moderate	Rana et al. (2010); Akhter et al. (2009)
Wildlife poaching	Moderate	Mukul et al. (2012b); Barlow et al. (2008)

CONCLUSION

The conservation effectiveness of protected areas depends on the effective management of surrounding landscapes of which they are a part (Chazdon et al. 2008; Hansen and DeFries 2007). The majority of the lands inside South Asia's forest protected areas are somehow altered by human activities and habitat conversions has not been adequately contained even after the legal initiatives taken by forest department through the declaration of protected areas (Clark et al. 2013). Many of the forest protected areas are also established in locations which are away from strategically important sites for

biodiversity conservation (Barnes et al. 2016; Venter et al. 2014; Saout et al. 2013). The Convention on Biological Diversity (CBD) Aichi Target 11 recently calls for a substantial increase in global protected area coverage by the year 2020, and to make a realistic progress towards this goal there is an urgent need to substantially enhance the management of existing protected areas with systematic conservation planning and management (Watson et al. 2014; Wilson et al. 2007).

Overall, we found that the current extent of forest protected areas in Bangladesh, both in terms of number and coverage is, inadequate to protect the rapidly dwindling biodiversity of the country. The forest protected areas also do not sufficiently represent the different forest ecosystems needing conservation. The lack of infrastructure and capacity of the Bangladesh Forest Department, limited involvement of, and support to local people (mainly through some project interventions) also obscuring the long-term sustainability and success of country's forest protected area systems.

To make the forest protected area systems efficient in conserving Bangladesh's unique biodiversity and ecosystems, strategical development is necessary with appropriate representation of critical wildlife habitats and corridors within the forest protected area network. A separate institutional body for FPA's management under the FD, standardized indicators for monitoring the success of FPAs, improvement in local capacity and funding, and effective involvement of local people in FPA's governance are crucial. Transboundary management and monitoring of forest protected areas are also necessary since the majority of the country's forest areas are bordered with neighboring India and Myanmar. Incorporation of ecosystem services (e.g., carbon sequestration, flood protection, etc.) framework in the FPA management and payments for ecosystem services could be some other avenues for future expansion and development in the country.

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Chapter 8

CONVERSION OF NATIVE VEGETATION IN PROTECTED AREAS FUELS CO_2-EQUIVALENT LOSSES IN UGANDA

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ABSTRACT

Protected areas (PAs) play many unique yet, irreplaceable ecosystem functions, most importantly, mitigation of CO_2 emissions. However, the

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influence of land use and land cover (LULC) change on the sequestration of carbon in these PAs and related ecosystems is strikingly limited. This chapter consolidates the scanty data on the impact of LULC change on biomass and soil carbon stocks for evaluation of the impact of such LULC changes on CO_2-equivalent (CO_2-e) fluxes in the PAs of Uganda. The gist of the study was to test the hypothesis that any change in LULC or shift away from the pristine LULC type (PAs in our case), would lead to a net CO_2-e loss. The results indicate that deliberate revegetation of an old (39–63 years) pine plantation segment of Kibale National Park with indigenous tree species resulted in a net 56.8% increase in CO_2-e sequestration (18.10 Mg CO_2-e ha^{-1}) in 10 years. In Mt Elgon National Park (MENP) with mature native forest (>80 years), over 87% of the CO_2-e was sequestered by mature trees in the intact tropical high forest (ITHF). A change in LC from an ITHF to a degraded tropical high forest (DTHF) to grassland has resulted in net losses of 91.5% and 93.6% of the CO_2-e sequestered by the ITHF, respectively. In Bwindi Impenetrable National Park, a shift from closed forest canopy (CFC) to open forest canopy (OFC) translated into a net loss of over 76.8% of CO_2-e. There was a significant effect of LULC change on the depth distribution of soil carbon stocks in KNP. Highest soil carbon stocks (19.0±0.86 Mg C ha^{-1}) were observed under maize whereas the smallest (16.4±1.54 Mg C ha^{-1}) were under ITHF. However, about 70% of the soil carbon stocks under the forest covers (11.2 Mg C ha^{-1}) were accumulated deeper than 0–0.15 m compared with only about 47% (about 8.9 Mg C ha^{-1}) under maize. The 2.3 Mg C ha^{-1} in the 0.15–0.6 m layer of soil under ITHF and restored forest in excess of what we observed under maize, highlights the importance of the forests in sequestering carbon in the area and potentially in related ecosystems elsewhere in Uganda. Our synthesis indicates that change in LULC or shift away from native LULC type leads to a net loss of CO_2-e. Therefore, conservation of such PAs in Uganda is not an option but mandatory for climate change mitigation.

Keywords: carbon sequestration, climate change mitigation, reforestation, land use, land cover

INTRODUCTION

Protected areas (PAs) globally play significant roles in sustainaing ecosystem functions and processes. They conserve biodiversity (Naughton and Chapman 2002; Omeja et al. 2011; FAO 2015; UWA-FACE 2015; Latja et al. 2016); protect soil from erosion and maintain soil fertility (FAO 2005, 2010, 2015); absorb flashfloods (Wijkman and Timberlake 1988) and purify both

surface and subsurface waters (Naughton and Chapman 2002); are heritage sites for ecotourism (UWA-FACE 2015); provide wood and non-timber forest products like timber, poles, fuel wood, wild foods, herbal medicines (Naughton and Chapman 2002); connect individuals and communities with their super natural worlds (Lyons and Westoby 2014); protect forests (Miranda et al. 2016); and offer opportunities for unique research and study purposes. Most importantly, PAs help mitigate extreme events associated with climate change (Lugo and Helma 2004; Maass et al. 2005; FAO 2007, 2010, 2011).

Globally, forests store about 289 Gt of carbon (1 Gt = 10^{12} g) in biomass alone (FAO 2010), representing about 1,060 Gt CO_2-equivalents (CO_2-e). Unfortunately, tropical forests accounted for nearly 94.41% of the 16.1 million ha of primary forests lost globally in the 1990s (Achard et al. 2004; FAO 2005). Between 2000 and 2010, about 52 million ha of tropical forest were lost (FAO 2010). In Uganda, tropical high forests (THFs) covered 39,942 km^2 of the country's approximately 241,551 km^2 early in the 19th century but by the year 2000, barely 5,000 km^2 of THF remained (Howard et al. 2000).

In Africa, avoided deforestation during the period 2003–2012 was estimated to have saved about 615.8 million Mg CO_2 from being emitted into the atmosphere (FAO 2007). Consequently, a number of projects have been initiated to circumvent greenhouse gas (GHG) emissions associated with loss of tropical forests (Lyon and Westoby 2014; FAO 2010; Jindal et al. 2008; UNEP 2008). In Uganda, Forest Rehabilitation Project promotes reforestation of 24,000 ha in Mount Elgon and Kibale National Parks (Jindal et al. 2008). However, very little has been done to evaluate the carbon sequestration potential of public forests and other PAs in the country. Uganda is among the countries that were not featured anywhere in the 208-page proceeding reporting about the status of carbon sequestration in Africa (FAO 2011). Nevertheless, out of the ten THFs gazetted and protected as national parks (NPs), published work exists on aboveground biomass (AGB) or biomass carbon estimates for three NPs: Mt. Elgon National Park (MENP) in eastern Uganda (Buyinza et al. 2014), Kibale National Park (KNP) in southwestern Uganda (UWA-FACE 2015; Omeja et al. 2012), and Bwindi Impenetrable National Park (BINP) also in southwestern Uganda (Otukei and Male 2015). Recently, Kiyingi et al. (2016) evaluated the carbon sequestration potential of commercial tree plantations in the Millennium Village Project districts still in southwestern Uganda where eucalyptus and pine are being promoted for the restoration of degraded PAs.

Even the limited data available for evaluating the sequestration potential of Uganda's PAs for CO_2 and other GHGs aboveground was scattered in

various journals and only one study had evaluated distribution of soil carbon stocks (Olupot et al. 2015). Elsewhere, metadata on global estimates of soil carbon stocks in forests (Guo and Gifford, 2002; Eclesia et al. 2012) had very limited coverage of tropical forest soils, especially in Africa. Moreover, there is as yet, no consensus on how much carbon is lost by changes in tropical land uses (Van der Werf et al. 2009; Eclesia et al. 2012). Wasige et al. (2014) evaluated soil carbon stocks in southwest Rwanda as a function of contemporary and historical LULC types, soil group, soil type and toposequence. They observed that soil carbon stocks were best explained by current LULC types and not by soil group or land cover (LC) conversion history. In addition, forest clearing for annual cropping resulted in the loss of 72% of soil carbon that had been sequestered under the forest whereas conversion of annual cropping into plantation forestry increased soil carbon stocks by 193%. About 75% of terrestrial carbon is in the soil (Schimel, 1995), more than 90% of it in form of soil organic matter (Schmidt et al. 2011), making soil the most important sink for terrestrial carbon.

This chapter focuses on consolidating the data on AGB and soil carbon stocks scattered in various peer-reviewed journal articles that we used to calculate CO_2-e as a function of LULC change in Uganda and to evaluate the impact of LULC change on CO_2-e fluxes. We tested the hypothesis that any LULC change or shift away from the pristine LULC type (PAs in our case), would result in net CO_2-e losses.

METHODOLOGY

Uganda lies on latitude 1.3733^o N and longitude 32.2903^o E and covers an estimated area of 241,551 km^2 and lies 4^o North and 1^o South of equator, on the East African Platea, one of the highest plateaus in the world (Yost and Eswaran, 1990). It is home to the largest tropical freshwater Lake in the world, Lake Victoria second overall, only to L. Superior and the longest River in the world, River Nile. There are 10 PAs officially gazetted as national parks in Uganda (Figure 1).

For details about KNP with regard to vegetation and land-use types see Figure 2. Omeja et al. (2012); Olupot et al. (2015) and UWA-FACE (2015) have detailed characteristics of the study sites, climate and methods for KNP. Omeja et al. (2012) quantified AGB accumulation of trees in three formerly encroached sites with different restoration strategies as a measure of the rate of regeneration: Site1: Pine plantation previously pristine THF that was

succeeded by grasslands (predominated by *Pennisetumpurpureum* and *Hyperrhenia*spp) following encroachment by pastoralists who abandoned the site due to outbreak of rindapest shortly after 1900 before pine plantation (*Pinuscaribaea*, *P. patula*, *Cupressuslusitanica*) was established between 1953 and 1977. At maturity, understorey of part of the pine plantation was successfully colonized by native tree species including: *Albiziagrandibracteata*, *Celtis Africana*, *Celtisarundii* and *Milletiadura*) and served as a control whereas part of it was deliberately planted with these very native tree species to serve as an experimental plot. Site2: Fire-controlled Ngogo grassland situated at the centre of KNP that had been protected from fires since the 1970s. The study was focused on Ngogo camp which was established 33 years ago, including a 12-year plot last burnt in 1996 and a 32-year plot not burnt since 1975 (by the time of the study). Site3: Most disturbed and intensively replanted, occupying about 120 km^2 located in the southern part of the park that was heavily encroached in the 1970s for agricultural conversion until Government evicted the encroachers in 1992, giving way to *P. purpureum*-dominated grassland. This site was gazetted for carbon-offset restoration programme jointly managed by both UWA and FACE Foundation, with eight compartments established on 10,000 ha in phase I (UWA-FACE 2015). Omeja et al. (2011) applied the forest inventory method which relates ground-based measurements of tree diameter or volume and wood density to carbon stocks (Gibbs et al. 2007). However, they developed own allometric functions for estimating AGB of regenerating forest, based on measurements on destructively sampled trees: diameter at breast height (DBH), diameter at ground height (DGH) and total length (L) of felled trees similar to the trees undergoing restoration. They used DGH and L to compute of volumes of individual trees because DGH predicted AGB better than DBH. Tree AGB was obtained by chopping and weighing the felled trees. Subsamples were oven-dried at 80^oC to constant weight (Temilola and Amanda 2010) for correction of moisture content of AGB.

Buyinza et al. (2014) also applied a forest inventory method (Gibbs et al. 2007) to estimate AGB in three LULC types in Mt Elgon National Park (MENP) in eastern Uganda (Figure 1): normal tropical high forest (THFN), encroached or degraded THF (THFD) and grasslands (agric plots – Figure 3) using allometric functions (with the smallest error terms) best suited to the study. Buyinza et al. (2014) assessed AGB in each LULC type at four levels: mature trees, poles, saplings and undergrowth and reported total AGB (TAGB) and derived carbon stocks from the methods proposed by IPCC (2003).

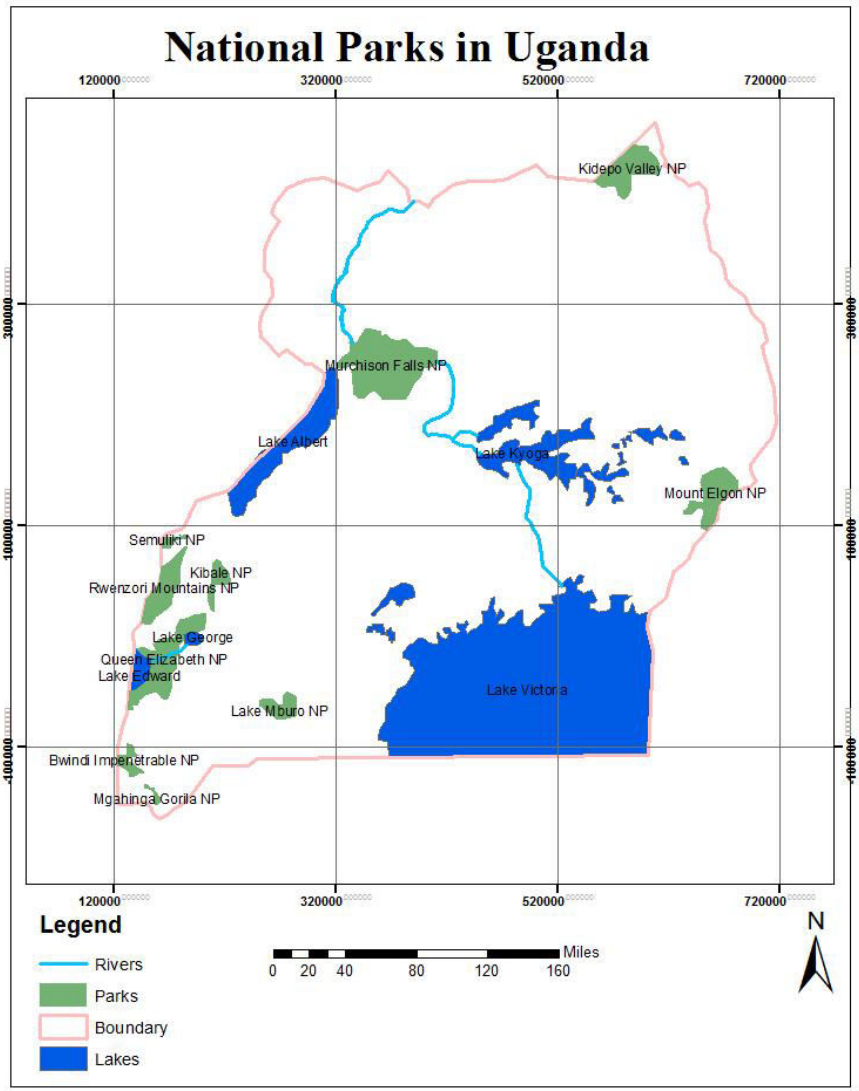
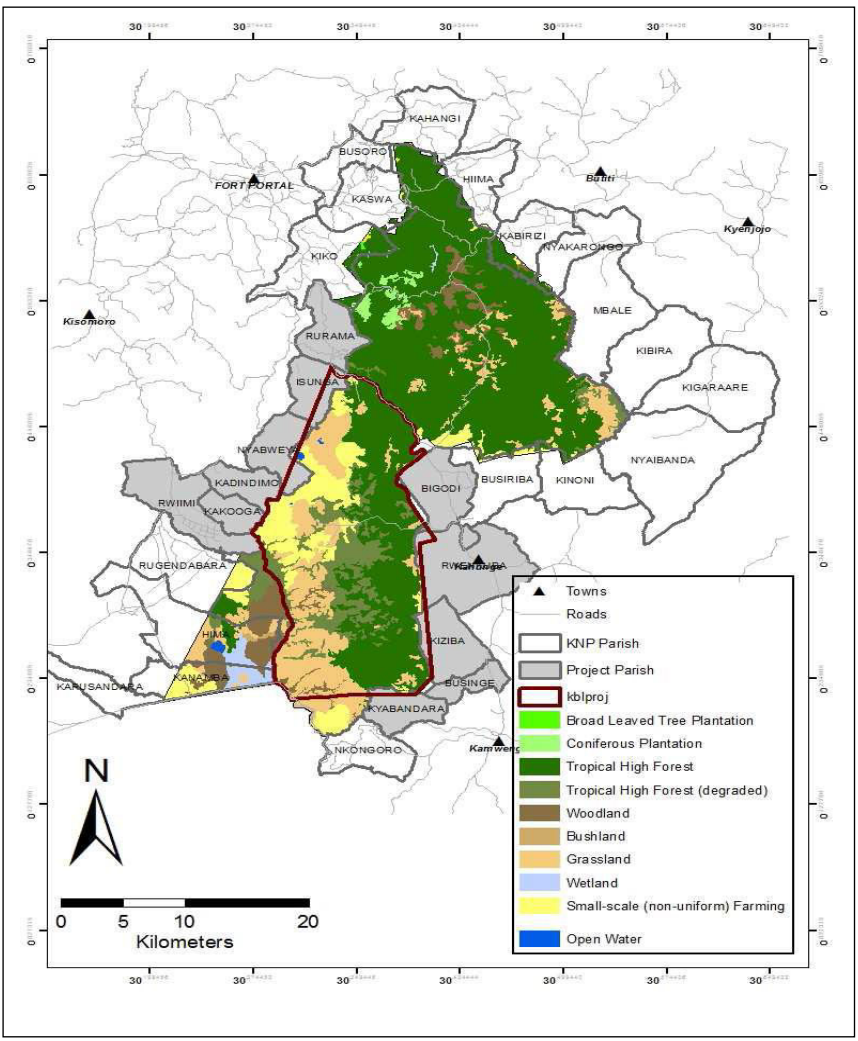
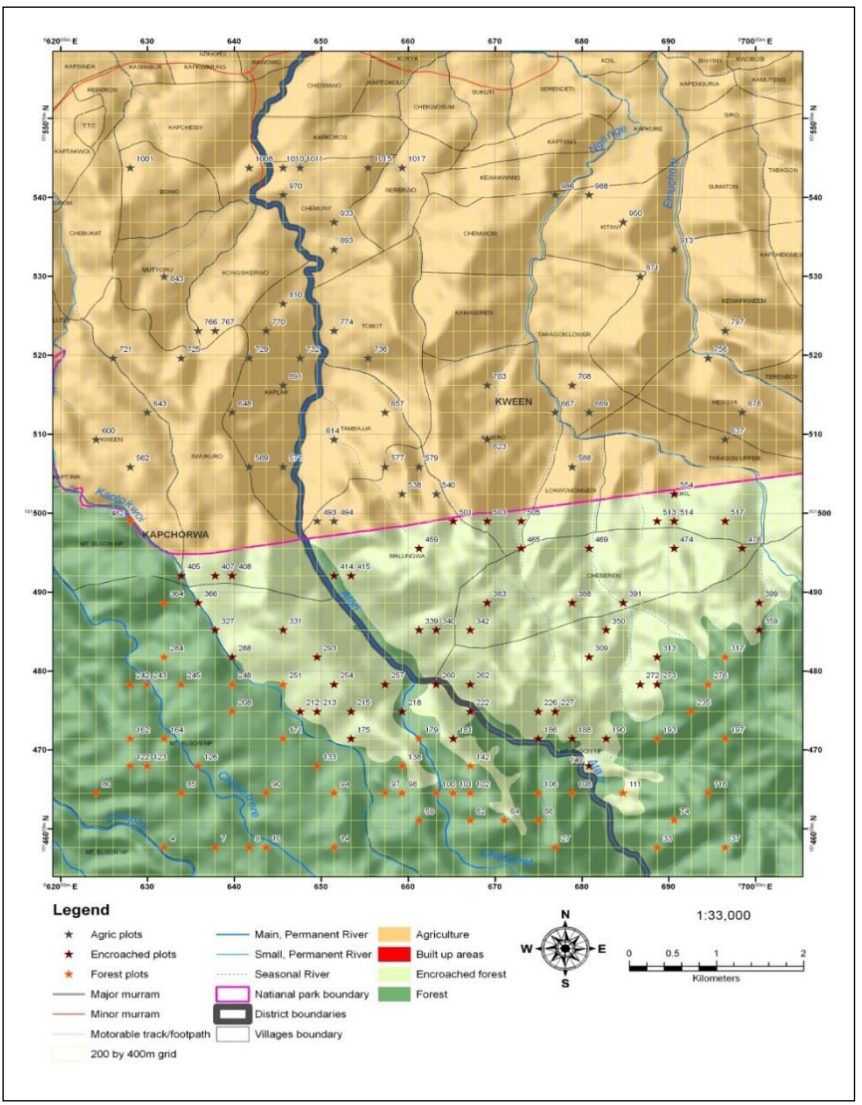


Figure 1. Map of Uganda highlighting the ten national parks.



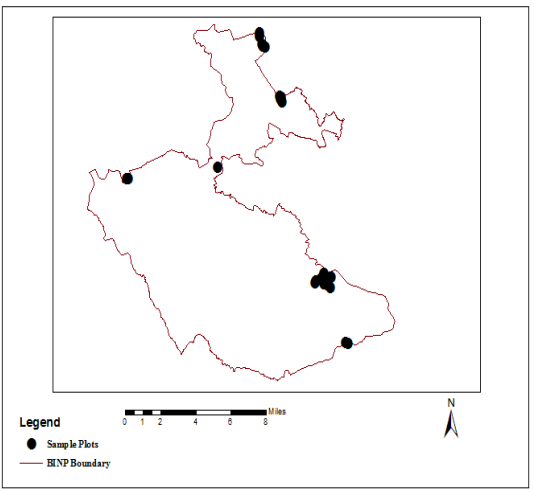
Source: Olupot et al. 2015.

Figure 2. Map of Kibale National Park highlighting the land cover types investigated for their potential to sink C in soil.



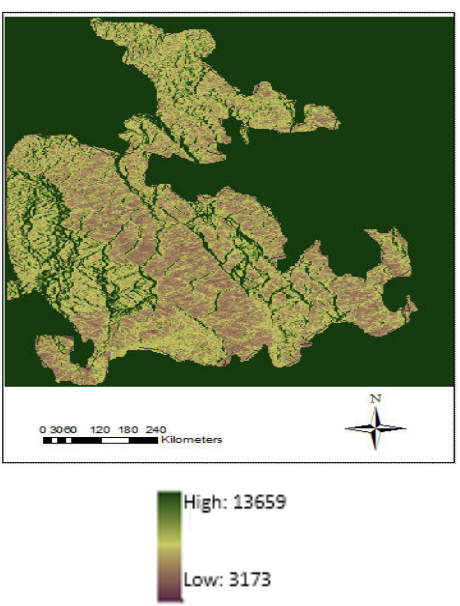
Source: Buyinza et al. 2014.

Figure 3. Land cover types investigated on Mt Elgon National Park, eastern Uganda with gridlines imposed on it.



Source: Oukei and Male 2015.

Figure 4. Map of Bwindi Impenetrable Forest National Park (BIFNP) highlighting sites where data for estimation of aboveground biomass and carbon stocks were collected.



Source: Otukei and Male 2015.

Figure 5. Estimated biomass carbon stocks in Bwindi Impenetrable Tropical High Forest in kg ha^{-1}.

Otukei and Male (2015) employed radar data from remote sensing sensor ALOS PALSAR which uses microwaves or radar signals to measure forest height and vertical structure in Bwindi Impenetrable Forest National Park (BINP). The study used both ALOS PALSAR and *in situ* data from selected sites (Figure 4) for estimating forest AGB and carbon stocks (Figure 5) following the IPCC (2003) method.

Kiyingi et al. (2016) also applied the forestry inventory method (Gibbs et al. 2007) customized to Uganda conditions (Table 1) to estimate AGB and CO_2-e in plantations of *Eucalyptus grandi* and *Pinuspurpureum* in the districts of Rubirizi and Mitooma located in south western Uganda. These are the most popular exotic species promoted for restoration of degraded PAs at least in Uganda, to offset CO_2 emissions under the Kyoto Protocol's Clean Development Mechanism (CDM) (UNFCCC 1997; IPCC 2003; BioCarbon Fund 2011) and for income generation. The eucalypt and pine plantations investigated were of ages 5, 10, 15 and 20 years. This is the first study to evaluate the profitability of tree plantations in Uganda. Data were collected from 94 and 106 plots of pine and eucalyptus, respectively, each of area 20 m * 20 m. Respective wood density and biomass expansion factor (BEF) of pine and eucalyptus were used to convert stem volume to total aboveground tree biomass:

$$B\text{uh}.t = V\text{h},t * \rho * \text{BEF} \quad (1)$$

the AGB of trees was converted into total tree biomass using the root : shoot ratio (R):

$$B\text{h}.t = V\text{h},t * \rho * \text{BEF} * (1 + \text{R}) \quad (2)$$

where, Buh,t= above-ground tree dry biomass in year t (Mg ha^{-1}); Bh,t= total tree dry biomass in year t(Mg ha^{-1}); Vh,t= stem volume (overbark to 5 cm top) in year t (m^3 ha^{-1}); ρ =wood density of the species (Mg m^{-3}).

Carbon stock (CO_2 equivalent; CO_2-e) in tree biomass per hectare in year t was estimated as:

$$CO_2\text{-e} = B_{h,t} * \text{CF} * (44/12) \quad (3)$$

where, CF = carbon fraction of tree biomass, assigned a default value of 0.5 (Brown 1997; IPCC 2003; McGroddy et al. 2004).

The AGB and carbon stocks data from KNP (Omeja et al. 2012), MENP (Buyinza et al. 2014) and BINP (Otukei and Male, 2015) were used to compute CO_2-e (Brown 1997; IPCC 2003; McGroddy et al. 2004). This facilitated the evaluation of CO_2-e emission mitigation potential of a particular LULC type in a given PA. A bio-sequence approach (Eclesia et al. 2012; Wasige et al. 2014; Olupot et al. 2015) was adopted to estimate the temporal impact of LULC change on CO_2-e sequestration potential (positive values) or emission potential (negative values) after a LULC change from any given 'pristine' PA.

Table 1. Regression equations used to estimate stem volume and biomass for *Pinuscaribaea*and *Eucalyptus grandis* (after Kiyingi et al. 2016)

Species	Volume equationa	n	R^2	Reference
Pinuscaribaea	$V = (0.5046 \ln(\sqrt{[10\,000/N]}) \cdot \exp[-7.2328 + 2.1619\ln(Hd) + \ln(N)]$	867	0.908	Alders et al. (2003)
Pinuscaribaea	$V10ub = 0.23232Dg\ 0.30142 \cdot V\ 1.02238$	867	0.998	Alders et al. (2003)
Eucalyptus grandis	$V = 0.008429(Hd - 2.5)2.148 \cdot N\ 0.4933$	346	0.959	Alders et al. (2003)
Eucalyptus grandis	$V10ub/V = 1 - \exp(-0.4327(Dg1 - 9.5)0.762)$	346	0.995	Alders et al. (2003), Shiver and Brister (1992)

*H*d is dominant height (m), *N* is stocking (trees ha^{-1}), *V* is total stem volume (overbark to 5 cm top, $m^3\ ha^{-1}$), *V*10ub is volume underbark to a 10 cm top diameter (merchantable volume; $m^3\ ha^{-1}$), *D*g is the stand mean basal area diameter (cm) (*P. caribaea*), and *D*g1 is the stand mean diameter (*E. grandis*).

The only available data on the distribution of soil carbon stocks down the soil profile as a function of LULC change was from KNP (Olupot et al. 2015). Details about how the soil carbon and related parameters for calculation of soil carbon stocks were measured are elucidated by Olupot et al. (2015). Soil carbon stocks were calculated by modifying the IPCC (2003) equation for calculation of soil organic C stocks:

$$\text{SOXstock} = \sum_{depthi}^{depthn} (SOX * bd * (1 - cf) * sd * 10 \qquad (4)$$

where, SOXstock is the SOC stock (Mg ha^{-1}); $depth_i$ is the initial depth sampled (0–0.15 m) whereas $depth_n$ is the final depth portion (0.45–0.6 m);

SOX is the SOC content (g C kg^{-1} soil) in a given depth portion sampled; *bd* is the soil bulk density of each intact soil core sample (Mg m^{-3}); *cf* is the coarse fraction of soil (>2 mm) that was discarded (% weight of total air-dried soil in a single sampled soil depth); sd is the soil depth portions (m) and 10 is the factor for converting mass in kg ha^{-1} into Mg ha^{-1}.

A paired-site (biosequence) approach was used to evaluate the impact of land cover change (LCC) on soil carbon stocks as well as for CO_2-e fluxes (for AGB carbon stocks). The percentage changes in soil C stocks were estimated from equation 5 (Eclesia et al. 2012):

$$SOXch = \left(\frac{SOXcu - SOXor}{SOXor}\right) * 100 \quad (5)$$

where, SOXch is the change in SOC stock (%) after a change in land cover type; SOXcu is the SOC stock (Mg ha^{-1}) in the soil under the current land cover type; and SOXor is the SOC stock (Mg ha^{-1}) in the soil under the native vegetation (assumed to be the ITHF in this study).

RESULTS

Biomass carbon stock CO_2-equivalents (CO_2-e) from Kibale National Park (KNP) indicate that nearly 18.1 Mg CO_2-e ha^{-1} was sequestered by indigenous trees deliberately planted on old pine plantations in excess of the control pine plantation over a period of 10 years (Table 2). Thus, deliberate revegetation of old pine sites with indigenous tree species resulted in a 56.77% increase in CO_2-e sequestration above the CO_2-e stocks in the old pine biomass over the same period (Table 3). Contrary to the convention that grassland ecosystems in KNP are symptomatic of a degraded forest, the grasslands sequestered the largest CO_2-e, of all the land cover types (LCTs) investigated. Interestingly, the disturbed grassland (that had been burnt 12 years back) sequestered larger CO_2-e (62.86 Mg ha^{-1}) than its counterpart that had not been burnt for > 32 years (54.80 Mg ha^{-1},Table 2). The heavily encroached and degraded part of KNP had the smallest CO_2-e sequestered 12 years after intensive revegetation with native tree species. This is reflected by the negative CO_2-e fluxes (net CO_2-e emissions) assuming a change from all of the other LC types to the restored forest (Table 3).

Table 2. Carbon stock CO_2-equivalents (CO_2-e) of biomass types as indicators of CO_2 emissions mitigation potentials for land use/land cover types over defined periods of time in selected protected areas of Uganda

Protected Area	Site/ characteristic	Land use/land cover type	Period (years)	CO_2-e (Mg ha^{-1})	CO_2-e (Mg ha^{-1} yr^{-1})
Kibale NP	1	Pine HC	10	31.81	3.181
Kibale NP	1	Pine HP	10	49.87	4.987
Kibale NP	2	Grassland FC	12	62.87	5.239
Kibale NP	2	GrasslandFC	32	54.80	5.480
Kibale NP	3	Degraded R	12	28.74	2.395
Mt Elgon NP	Trees	Intact THF	80	1018.05	12.73
Mt Elgon NP	Poles	Intact THF	8	1.76	0.22
Mt Elgon NP	Saplings	Intact THF	5	40.66	8.13
Mt Elgon NP	Undergrowth	Intact THF	20	16.24	0.81
Total				1076.71	21.89
Mt Elgon NP	Trees	Degraded THF	27	55.11	2.04
Mt Elgon NP	Poles	Degraded THF	8	0.55	0.07
Mt Elgon NP	Saplings	Degraded THF	5	4.40	0.88
Mt Elgon NP	Undergrowth	Degraded THF	20	31.61	1.58
Total				**91.67**	**4.57**
Mt Elgon NP	Trees	Grassland	27	8.51	0.32
Mt Elgon NP	Poles	Grassland	8	2.97	0.37
Mt Elgon NP	Saplings	Grassland	5,	0.18	0.04
Mt Elgon NP	Undergrowth	Grassland	20	57.13	2.86
Total				**68.79**	**3.59**
Bwindi IFNP	Total	Intact THF	-	50.04	-
Bwindi IFNP	Total	Degraded TFH	-	11.62	-
SW Uganda	Young poles	*Eucalyptus*	5	172.73	34.55
SW Uganda	Mature poles	*Eucalyptus*	10	245.55	24.56
SW Uganda	Young trees	*Eucalyptus*	15	518.18	34.55
SW Uganda	Mature trees	*Eucalyptus*	20	590.91	29.55
SW Uganda	Young poles	*Pinuscaribaea*	5	54.55	10.91
SW Uganda	Young poles	*Pinuscaribaea*	10	127.27	12.77
SW Uganda	Young trees	*Pinuscaribaea*	15	218.18	14.55
SW Uganda	Mature trees	*Pinuscaribaea*	20	318.18	15.91

NP = national park, Pine HC = pine harvested but site not replanted (acted as control), Pine HP = pine harvested and the site replanted with native tree species (experimental site), Grassland FC = grassland where fire was controlled (not burnt for either 12 or 32 years), Degraded R = heavily encroached and degraded forest that was restored by intensive replanting with native trees, THF = tropical high forest, IFNP = impenetrable forest national park, SW = southwestern (where Kibale NP and Bwindi INP are also located, *Eucalyptus* = *Eucalyptus grandis*, - = not established.

Table 3. Impact of land use/land cover change on carbon stock CO_2-equivalents (CO_2-e) as an indicator of net CO_2 emissions (negative) or sequestration (positive) in selected protected areas of Uganda

Protected Area	Land use/land cover change	Period (yrs)	Net CO_2-e flux (%)	Net CO_2-e flux (% yr^{-1})
Kibale NP	Pine HC to Pine HP	10	56.77	5.68
Kibale NP	Grassland32 to Grassland12	12	14.73	1.23
Kibale NP	Pine HC to Restored THF	12	-9.65	-0.80
Kibale NP	Pine HP to Restored THF	12	-42.37	-3.53
Kibale NP	Grassland to Restored THF	12	-54.29	-4.52
Kibale NP	Grassland to Restored THF	32	-45.55	-1.49
Mt Elgon NP	Intact THF to Degraded THF	27	-91.49	-3.39
Mt Elgon NP	Intact THF to Grassland	27	-93.61	-3.47
Bwindi IFNP	Intact THF to Degraded THF	27	-76.78	-2.84

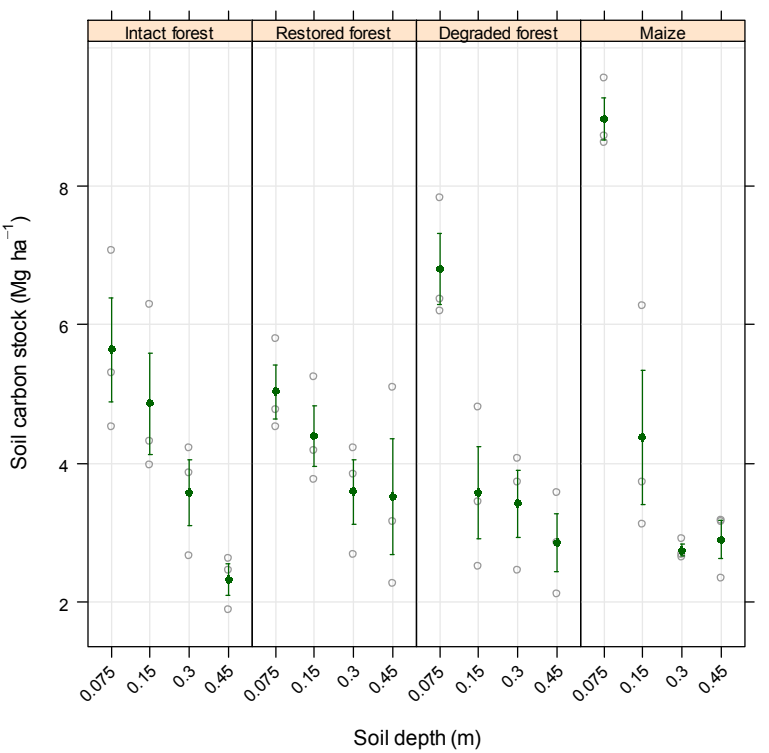
NP = national park, Pine HC = pine harvested but site not replanted (acted as control), Pine HP = pine harvested and the site replanted with native tree species (experimental site), Grassland12 = grassland where fire was controlled and not burnt for at least 12 consecutive years, Grassland32 years = grassland where fire was controlled and not burnt for at least 32 consecutive years, Restored THF = heavily encroached and degraded forest that was restored by intensive replanting with native trees, Intact THF = intact tropical high forest, Degraded THF = degraded tropical high forest, IFNP = impenetrable forest national park.

In Mt Elgon National Park (MENP), over 87% of the CO_2-e was sequestered by mature trees in the intact tropical high forest (ITHF) (Table 2). A change in LC from an ITHF to a degraded tropical high forest (DTHF) and from ITHF to grassland would translate into a net loss of 91.49% and 93.61% of the CO_2-e sequestered by the ITHF, respectively (Table 3). Mature trees and undergrowth were the most important sinks for CO_2-e in the degraded forest whereas undergrowth was the most important for the grassland (Table 2), making their management very critical.

Estimated biomass carbon stocks in Bwindi Impenetrable National Park (BINP) ranged from 3.17 Mg ha^{-1} to 13.66 Mg ha^{-1}. This translated into carbon stocks CO_2-e of 11.62 Mg ha^{-1} in open forest canopies (OFCs) to 50.04 Mg ha^{-1} in closed forest canopies (Table 2). Thus, a shift from CFC to OFC cover would translate into a net loss of over 76.78% of CO_2-e (Table 3). Still in southwestern Uganda, at any stage of growth, CO_2-e values were consistently higher in *Eucalyptus grandis* plantations than in the biomass of *Pinuscaribaea* (Table 2).

For distribution of soil carbon stocks in KNP, we observed the largest soil carbon stocks in the 0 – 0.15 m depth (10 ± 0.3 Mg ha^{-1}) under corn (*Zea mays*) whereas the smallest soil carbon stock in the same depth (5.0 ± 0.83 Mg ha^{-1}) was under RTHF (Figure 6) that also had the smallest CO_2-e (Table 2). The fraction of soil carbon stocks located in the 0.15 – 0.6 m by LCT was in the order of RTHF > (70%) > ITHF (66%) > DTHF (59%) >*Z. mays* (47%). Thus, RTHF and ITHF have a significantly larger fraction of their soil carbon stocks in the 0.15 – 0.6 m layer than DTHF and corn (*Z. mays*).

We selected ITHF as the reference land cover against which soil carbon stocks from the other land cover types were compared. Generally, the changes in soil carbon stocks were all positive though very small, with no significant effect of LULC change. The highest soil carbon (15.8%) change was from ITHF to *Z. mays* whereas the smallest (0.8% C) was from ITHF to RTHF.



Source: Olupot et al. 2015.

Figure 6. Impacts of land cover type (top x-axis) on distribution of SOC stocks (Mg ha^{-1}) with soil depth (in m) in Kibale National Park, western Uganda.

DISCUSSION

By the year 2000, Uganda had lost 87.5% of her primary forest cover, excluding other PAs that are not necessarily forests in the country, especially those not under the jurisdiction of Uganda Wildlife Authority. Based on evidence from KNP, we observed that regardless of the regeneration pathway, grasslands with controlled burning sequestered the largest CO_2-e. A change from this particular LC type to restored forest would lead to a loss of 54.29% of the CO_2-e sequestered by the 12-year old grassland from the time it was last burnt and this value would be much higher without the restoration efforts. Omeja et al. (2012) attributed the superiority of disturbed grassland over the grassland not burnt for 32 years to succession of high-density native species of the grassland by lighter species with the aging of the grasslands. Controlled burning has, for long, been used as a strategy for pasture management in pastoral lands and game parks, with mixed effects of fires on biodiversity (Klomp 2009).The classification of OFC dominated by grasslands as 'degraded forest' in KNP seems to make 'technical' or 'political' but not a scientific sense. The grassland (C_4) and tree (C_3) vegetation types seem to have for time immemorial, competed to colonise KNP such that a closed canopy supports C_3 vegetation whereas an open canopy favors C_4 vegetation. A net gain in CO_2-e sequestration averaging about 5.68 Mg ha^{-1} yr^{-1}, over the 10-year monitoring period following deliberate revegetation of a segment that had been under pine with native trees is evidence that indigenous vegetation is superior to exotic species that are being promoted in terms of CO_2-e sequestration. It is also important to note that the 12-year monitoring period might have been short for the tree-based restored segments of KNP as the trees might still have been growing and therefore, actively sinking CO_2-e. Unfortunately, Omeja et al. (2012) did not report AGB of the ITHF with relatively mature trees and the degraded forest before it was restored, which would have helped paint a clear picture on the exact nature and direction of CO_2-e gradients associated with the land use changes that took place.

In MENP where the ITHF was at least 80 years since the last gazetting of this PA as a Crown Forest in 1936 (Luzinda, 2008) and therefore, with mature trees, almost 91.85% of CO_2-e was sequestered by mature trees. Over 91.49% of the CO_2-e sequestered in ITHF has been lost following encroachment of MENP almost 27 years ago. The situation is expected to worsen, given the level of encroachment and the rate at which the communities are replacing indigenous vegetation with commercial trees species like pine and eucalyptus (Figure 7). The message to concerned policy makers, enforcement authorities

and agencies is that it is much easier and cheaper to conserve existing PAs than to restore those that have been degraded to a level where restoration may be impractical or uneconomical.

In BINP, as much as 76.78% of the CO_2-e sequestered in the closed forest canopy (CFC) has been lost following its transition into OFC. Given that BINP is one of the top destinations for tourists coming to East Africa, it is possible that a win-win for both economic and environmental wellbeing can be attained by closing the OFC gaps, as it could translate into more mountain gorillas and a 76.78% gain in CO_2-e sequestration.

Although plantation forests such as pine and eucalyptus have a potential to sequester CO_2-e (Kiyingi et al. 2016) and are being actively promoted (Lyons and Westoby 2014), experience from KNP with one of the oldest pine plantations indicates that native tree species are superior. The actual driver of adoption of plantation forestry is the perceived 'quick money' from the 'relatively first-growing' pine and eucalyptus species being promoted in Uganda rather than for CO_2-e sequestration. This view is evident in the concluding remarks by Kiyingi et al. (2016) that the Kyoto Protocol's CDM price of US $ 4.15 Mg^{-1} CO_2-e with a 20-year rotation should be increased to make it profitable for eucalyptus as the 10-year rotation which is considered the economically optimum period for harvesting eucalyptus, seems more profitable. No wonder the rate of deforestation in commercial private tree plantations is as much as eight times that on public (protected) forests (Bakiika 2013). The tendency to associate large-scale commercial tree plantations with 'modernity', 'powerfulness' and 'elite' and 'first class citizenry' but indigenous approaches to sequestration of CO_2-e with 'primitivity', 'inferiority' and 'backwardness', not only constitutes an emerging threat to PAs in Uganda, but also to the irreplaceable ecosystem functions that these PAs perform and livelihoods of the indigenous peoples to which these PAs mean everything. Lyons and Westoby (2014) argue that this development is ushering in a new form of colonialism in Uganda and indeed Africa, in the name of 'greening the economy and mitigating climate change'. Most importantly, owing to the unique geomorphology of Uganda, nearly all the PAs gazetted as national parks are important catchments for L. Victoria and R. Nile without which, Egytp and other lower riparian states would not be what they are today and Mediterranean Sea would be too salty for life.

Figure 7. One of the heavily encroached and degraded parts of Mt Elgon under the World Bank-supported Sustainable Land Management Project. Note the miserable corn crop on depleted red soils (foreground) and eucalyptus interplanted with bananas (background) in a previously dense tropical high forest and banana-coffee farming system.

The impact of LULC type on soil carbon stocks was depth-specific implying that reporting total soil carbon stocks without accounting for the pattern of their distribution down the soil profile can mask localised depth-specific effects of LULC type on these stocks. This information is needed to identify LULC types that are sequestering larger carbon stocks in deeper soil horizons such as ITHF and RTHF that had 66% and 70% of soil carbon stocks deeper than 0.15 m respectively, highlighting the importance of these forests in long-term carbon sequestration belowground. The carbon in deeper soil layers is less susceptible to losses because the soil is subject to less disturbance, lower temperatures, higher micro-porosity and anoxic conditions and low microbial activities that favourcarbon preservation (Rasse et al. 2005). The 53% soil carbon stock (> 10 Mg C ha^{-1}) concentrated near the soil surface (0 – 0.15 m depth) that is most disturbed as under *Z. mays* is prone to high losses (Rasse et al. 2005). Tropical forests tend to root deeper with as much as 76% of the root systems being fine roots (Kirsi and Sisko 1999), which can transfer large quantities of photo-assimilated C into soil.

The lack of Lack of a significant impact of LULC type on total soil carbon stocks could be due to large errors resulting from few (three) replications and the bulking of spot soil samples to get composite samples in the study by Olupot et al. (2015). Interestingly, total soil carbon stocks under forest covers in KNP (> 16 Mg C ha^{-1}) were higher than the 7.1 Mg C ha^{-1} or 2.1 Mg C ha^{-1} reported for aboveground biomass of planted vs and naturally regenerated trees, respectively in KNP (Omeja et al. 2011). Total soil carbon stocks were also higher than the 2.9 to 12.3 Mg C ha^{-1} range for the aboveground biomass in BINP (Otukei and Male 2015). The soil carbon stocks could have been even higher, had Olupot et al. (2015) extended the sampling beyond 0.6 m.

Although no significant changes in soil carbon stocks with LC change were observed, it is important to note that at least 53% of the soil carbon under maize (corn) was mainly in the top 0.15 m where it is vulnerable to high losses (Rasse et al. 2005).

CONCLUSION AND FUTURE OUTLOOK

This is the first attempt to consolidate the limited research on CO_2-e sequestration in Uganda's PAs that was scattered in the various s peer-reviewed literatures. The methods used in the various studies are categorized as those of low-to-medium uncertainty, implying that the data are fairly accurate (Gibbs et al. 2007). However, the forest inventory methods are laborious, time-consuming and difficult to apply for dense forest canopies, and are highly locality-specific (Otukei and Male 2015). More robust, fast and nondestructive methods for estimating biomass CO_2-e that can be used repeatedly with a high potential for extrapolation to large areas are needed to increase availability of data on CO_2-e in Uganda beyond the three national parks. These include use of laser, radar, and optical remote sensors as well as biome averages that rely on a variety of input data sources to accurately estimate mean forest carbon stocks for broad forest categories (Gibbs et al. 2007). Only one study (Kiyingi et al. 2016) estimated total (both above and belowground) tree biomass whereas the rest relied on only total AGB. To paint a complete picture of net ecosystem productivity and the total CO_2-e in biomass, better insights into belowground biomass are needed using both destructive and nondestructive methods.

Rigorous experiments both laboratory and *in situ* involving pulse or continuous isotope labeling of test plants with $^{\delta}C^{13}$ are needed to establish the amount of carbon fixed photosynthetically, partitioning of photoassimilated

carbon between the shoots and roots, ascertain the rate of transfer and fate of this carbon in the soil-plant-atmospheric conitinuum coupled with advances that are being made in measurement of soil moisture, soil temperature and photosynthetically active radiation before a full picture of the role of plants in CO_2-e sequestration is known. Only one study examined soil carbon distribution down the soil profile across contrasting LULC types and the impact of LU change on soil carbon stocks. Beyond extending such measurements of soil carbon stocks to other PAs and related ecosystems to at least 1.0 m deep, tremendous effort is needed to ascertain carbon fluxes associated with soil respiration in both laboratory and *in situ*, taking advantage of the advances that are being made in this area (FAO 2011). Studies that rely on soil carbon stocks fail to account for the amount of carbon lost through respiration, which can be large (Kuzyakov and Domanski 2000) and therefore, do not give a full picture of carbon sequestration in soil. Natural abundance techniques that rely on the differences in preference for $^{\delta}C^{14}$ between C_3 and C_4 vegetation are needed to establish the age of carbon in soil (mean residence time) and the major source of this carbon: grasslands (C_4) or trees (C_3) in KNP and related ecosystems elsewhere. In summary, insights into the role of PAs in sequestering CO_2-e and how this is affected by changes in land use and management are only in their nascent stages in Uganda.

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Chapter 9

VASCULAR PLANTS AT THE PROTECTED AREAS NETWORK OF THE REPUBLIC OF MORDOVIA: PRESENT STATUS AND PROSPECTS

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ABSTRACT

The Republic of Mordovia is located in Central Russia in the boundary of the Volga Upland and the Oka-Don Lowland in the range of conifers, deciduous forests and forest-steppe zones. The range limits of many vascular plant species are located in region. At present, most natural ecosystems are influenced by human. Most steppe plots are used as arable lands and pastures, some of which are abandoned lands. For a long time, forests had been cut down for various purposes (agriculture organisation, pearl ash production, timber production). Relatively intact

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or slightly disturbed vegetation elements remained in plots that are unsuitable for agriculture and on the Protected Areas (PAs). The anthropogenic impact on the environment has caused the reduction in the number of populations for some plant species known in Mordovia. Most of them are included in the regional Red Data Book. Network of Protected Areas contributes to the conservation of natural ecosystems and populations of rare and endangered plants in Mordovia. However, many populations of rare species of the Republic of Mordovia remained outside these PAs. 2004–2015, we have identified and recommended about 70 plots for organisation of their protection as a botanical PAs. In this chapter, we analyse the distribution and population of rare species in existing PAs of the Republic of Mordovia. We demonstrate increase of the representativeness of the PAs Networks (percent increase of number of rare plant populations presented in the PAs) due to its reorganisation. The reorganisation lies in the fact that the PAs Network will include all plots that we have recommended for organisation of the PAs in 2004–2015. These PAs are crucial for the conservation of flora and vegetation of the Central Russia. Taxonomical, ecological-coenotical and geographical analysis of rare plant species of the Republic of Mordovia was conducted.

Keywords: rare plant species, conservation, Red Data Book, Republic of Mordovia, nature conservation

INTRODUCTION

The importance of biodiversity for a healthy and equitable society has been acknowledged by over 190 countries that ratified the Convention on Biological Diversity. The Tenth Conference of Parties of the Convention on Biological Diversity was ended by the International Year of Biodiversity and initiative "Countdown 2010". Initially, aim was to achieve a significant reduction of the rate of biodiversity loss since 2001 until now (Balmford et al. 2005). Tenth Conference has confirmed the absence of the biodiversity loss (Jones et al. 2011). That is why new strategic goals to be solved in the next decade have been formulated in so-called "Aich Biodiversity Targets" (SCBD 2010). Amongst five main strategic goals, two (*Strategic Goal B*: Reduce the direct pressures on biodiversity and promote sustainable use and *Strategic Goal C*: To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity) are associated with conservation of rare species

populations using Protected Areas. Creation of PAs Networks serves to establish of liaisons between cenopopulations of rare plants across the region (Bilz et al. 2011).

Now, PAs Network of Russia is presented by state reserves, national parks, natural parks, federal and regional preserves, natural landmarks and botanical gardens. Excluding last PA type, PAs are terrestrial or water territories having special conservation-oriented, scientific, cultural, aesthetic or recreational significance (Federal Law of the Russian Federation 1995). Mostly, these are areas with preserved, little-damaged natural environment and its inhabitants.

Republic of Mordovia covers area of 26,200 km^2. It is located on the border of the forest and forest-steppe zones in Central Russia (Figure 1). Eastern Mordovia covers the north-west of the Volga Upland, but the western part of region is located on the Oka-Don Lowland. Therefore considerable diversity of habitats is observed within this area. Coniferous and mixed forests are distributed in the west, north-west and north parts of Mordovia. Broad-leaved forests are located in the central and eastern parts. Forest-steppe landscapes dominate in the east and south-east parts of Mordovia (Yamashkin 1998, 2012). This is explained by high diversity of biotopes within Mordovia. That is why plants from different coenotic groups can grow within its region.

Data on the distribution, composition of flora and fauna and status of PAs Network are scattered in the country. Moreover, these data often descriptive in nature (Kuznetsov and Silaeva 2008; Silaeva et al. 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015; Vargot et al. 2015, 2016). There is only a little number of publications devoted to analysis of rare plant species distribution at PAs Network of the Republic of Mordovia (Silaeva et al. 2010a; Khapugin and Silaeva 2013; Khapugin et al. 2017). Therefore, composition and structure of the flora in the PAs Network require a special attention.

In this chapter, we have generalised all available data about populations of rare plant species of the Republic of Mordovia; the representativeness of existing PAs Network was assessed. We compare the level of protection achieved by the current PAs Network, and the level of protection that an extended Network including new PAs recommended in the period 2004–2015 would provide (Silaeva et al. 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015). Taxonomic, coenotical, geographical analysis of the flora of rare plants species was carried out.

Figure 1. Location of the Republic of Mordovia in Russian Federation (Map with modifications from web site BankGorodov.RU: www.bankgorodov.ru).

Species Richness and Analysis of the Flora of Rare Vascular Plants in the Republic of Mordovia

In 2015, the list of plant species included in second edition of the first volume of the Red Book of the Republic of Mordovia was approved (Resolution…, 2015). Many new populations of rare plant species were found in Mordovia during the period of 2004–2015. That is why, in compare to the first edition of the first volume of the regional Red Data Book (Silaeva 2003), rarity categories for several plant species have been changed. Some species were firstly included in the Red Data Book of Mordovia. On the other hand, some plants were excluded from the list of species needed in special protection within a region. The list of vascular plants included in the second edition of the first volume of the Red Data Book of the Republic of Mordovia is presented by 164 species including 2 species of Lycopodiopsida, 5 – Polypodiopsida (including 2 species from Ophioglossidae, and 1 species from Equisetidae), 1 – Pinopsida, 1 – Gnetopsida, and 155 species of Magnoliopsida (90 – dicotyledons, 65 – monocots).

The most number of species are contained in following families: *Orchidaceae* Juss. (18 species), *Asteraceae* Bercht. and J. Presl. (17 species), *Poaceae* Barnhart. (16 species), *Cyperaceae* Juss. (14 species) (Table 1). Significant number of rare and endangered species in *Orchidaceae* family confirms the vulnerability and sensitivity of orchid populations that is consistent with works of other authors (Wotavova et al. 2004; Khapugin et al. 2014; McCormick and Jacquemyn, 2014; Khapugin and Chugunov, 2015; Khapugin et al., 2016). Families Asteraceae and Poaceae also contain high number of rare plant species; similarly these families occupy leading positions in the taxonomic structure of the flora of the Republic of Mordovia as a whole (Silaeva, 2010a). The high position of *Cyperaceae* family can be explained by high diversity of biotopes inhabited by these species: steppes (e.g., *Carex pediformis* C.A. Mey., *C. supina* Wahlenb.), wet meadows (e.g., *Carex tomentosa* L., *C. flava* L.), oligotrophic bogs (e.g., *Carex limosa* L., *Rhynchospora alba* (L.) Vahl).

Table 1. Families of the flora of rare vascular plants of Mordovia ranked by species number

№	Family	Number of rare plant species per family in Mordovia	Percentage of the number of rare plant species in family to the total number of rare plant species of the Republic of Mordovia, %
1	*Orchidaceae* Juss.	18	11.0
2	*Asteraceae* Bercht. and J. Presl	17	10.4
3	*Poaceae* Barnhart	16	9.8
4	*Cyperaceae* Juss.	14	8.5
5	*Scrophulariaceae* Juss.	12	7.3
6	*Ranunculaceae* Juss.	8	4.9
7	*Fabaceae* Lindl.	7	4.3
8	*Caryophyllaceae* Juss.	6	3.7
9	*Ericaceae* Juss.	5	3.0
10	*Rosaceae* Juss. nom cons.	5	3.0
Total		108	65.9

We carried out geographic analysis of the flora relatively to belonging to groups of longitudinal and latitudinal ranges. The widest groups of longitudinal ranges contain the most number of rare plant species (Table 2). Amongst them are Euro-Siberian (53 species), Holarctic (36), Euro-Asian (35), European (25 species) groups of longitudinal ranges. Narrowly-endemic

plant species are absent in Mordovia. This fact indicates that plant populations may be threatened with extinction in certain parts of its range despite the fact that the whole range of this plant is fairly wide. Therefore, conservation of plant populations in certain regions is especially important action in conditions of an anthropogenic influence observed currently in worldwide.

Table 3 shows that the most part of rare plants in the Republic of Mordovia belong to boreal (42 species), steppe (39 species) and forest-steppe (38 species) groups. It is explained by the location of Mordovia at the boundary of taiga, steppe and forest-steppe natural zones. Due to this fact, range limits of these plants are arranged in Mordovia. Even four hypoarctoboreal species *Huperzia selago*, *Potamogeton alpinus*, *Andromeda polifolia*, *Arctostaphylos uva-ursi* are known here; of these, *Huperzia selago* and *Arctostaphylos uva-ursi* are considered as extremely rare and vulnerable plants in the Republic of Mordovia. Single semi-desert species *Krasheninnikovia ceratoides* is known in Mordovia in isolation from the main part of its range.

Coenotical analysis is used to show in which habitats (plant communities) plant species are known in a certain territory. Coenotical analysis of the flora of rare plant species of the Republic of Mordovia shows that the highest number of species is confined to steppe communities (Table 4). This fact confirms vulnerability and significance of steppe areas in Mordovia to protect steppe plant populations. Significant number of rare species is plants confined

Table 2. Longitudinal ranges of the flora of rare vascular plants of the Republic of Mordovia ranked by species number

№	Groups	Number of rare plant species per group in Mordovia	Percentage of the number of rare plant species in a group to the total number of rare plant species of Mordovia, %
1	Euro-Siberian	53	32.3
2	Holarctic	36	22.0
3	Euro-Asian	35	21.3
4	European	25	15.2
5	Euro-Ancient Mediterranean	9	5.5
6	Euro-Siberian-Ancient Mediterranean	4	2.4
7	Multiregional	1	0.6
8	Euro-North Anerican	1	0.6
Total		164	100.0

Table 3. Latitudinal ranges of the flora of rare vascular plants of the Republic of Mordovia ranked by species number

№	Groups	Number of rare plant species per group in Mordovia	Percentage of the number of rare plant species in a group to the total number of rare plant species of the Republic of Mordovia, %
1	Boreal	42	25.6
2	Steppe	39	23.8
3	Forest-steppe	38	23.2
4	Boreal-nemoral	18	11.0
5	Multizonal	14	8.5
6	Hypoarctoboreal	4	2.4
7	Nemoral and Forest-steppe	4	2.4
8	Nemoral	4	2.4
9	Steppe and Semi-desert	1	0.6
Total		164	100.0

to the forest communities. It should be noted, that 72.1% of these are plant of boreal coniferous forests. This is also associated with fact that the range limit of *Picea abies* is arranged in the Republic of Mordovia. These two first groups (steppes and forests) contain 109 species (66.5% of total number of rare plant species in Mordovia) which are located mostly at their limits of ranges. This is a result of Mordovia position at the border of taiga and steppe natural zones. As it was proposed and confirmed earlier (Channell, 2004; Gaston, 2003; Abeli et al. 2014), such periferal plant populations are considered as the most vulnerable and sensitive components of natural ecosystems.

Table 4. Coenotical groups of rare plants in the Republic of Mordovia

№	Groups of habitats	Number of rare plant species per group in Mordovia	Percentage of the number of rare plant species in the group to the total number of rare species in the Republic of Mordovia, %
1	Steppes	66	40.2
2	Forests	43	26.2
3	Terrestrial wetlands	26	15.9
4	Aquatic wetlands	14	8.5
5	Forests and meadows	8	4.9
6	Meadows	7	4.3
Total		164	100.0

SPECIES DISTRIBUTION BY CATEGORIES OF THE RED DATA BOOK

The new, second, edition of the Red Data Book of the Republic of Mordovia includes 164 species. Results of the field studies of rare plants have been published in previous years (Silaeva et al. 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015). They have contained information about new findings of rare species in the Republic of Mordovia and about areas that have been recommended to PAs establishing. Vascular plants of the regional Red Data Book have the rarity categories from "0" to "4" (Table 5). Descriptions of these rarity categories are listed below.

1. *Probably extinct species*. Populations of these plants have probably disappeared from the territory of the Republic of Mordovia. These plants have not been recorded in the wild during the past 50 years, either in points where the species were known to be formerly present, or at any other potential locations. Nevertheless, the possibility that some individuals or populations have been overlooked due to dormancy cannot be completely excluded. Under favorable conditions, plants develop vegetative and /or generative organs and become detectable.
2. *Endangered species*. Species whose populations have reached critically small sizes and / or their habitats have changed in such a way that their survival is unlikely if the impact of threat factors persists.
3. *Vulnerable species*. Species characterised by steadily declining populations in the region, which can quickly fall into the category of endangered species if impacts of unfavorable factors persist.
4. *Rare species*. Species of high vulnerability because of their small population size in the region. They are distributed over a limited area or a large scale, but in a very low density.
5. *Indeterminate species*. Species whose populations could be classified into one of the previous categories, but information about their present state is insufficient to accurately determine their status.

Table 5. Vascular plants included in second edition of the Red Data Book of the Republic of Mordovia distributed by rarity categories

Category	Species	Number of species
0 – Probably extinct	*Diplazium sibiricum* (Turcz. ex C. Kunze)	4
	Botrychium matricariifolium A. Braun ex Koch	
	Orchis ustulata L.	
	Silene steppicola Kleopov	
1 – Endangered	*Allium cretaceum* N. Friesen and Seregin	63
	Alnus incana (L.) Moench	
	Amygdalus nana L.	
	Andromeda polifolia L.	
	Arctostaphylos uva-ursi (L.) Spreng.	
	Astragalus asper Jacq.	
	Astragalus sulcatus L.	
	Avenella flexuosa (L.) Drejer	
	Botrychium virginianum (L.) Sw.	
	Carex chordorrhiza Ehrh.	
	Carex dioica L.	
	Carex flava L.	
	Carex hartmanii Cajand.	
	Carex pediformis C. A. Mey.	
	Caulinia tenuissima (A. Br.) Tzvelev	
	Clematis recta L.	
	Corallorhiza trifida Chatel.	
	Cypripedium guttatum Sw.	
	Digitalis grandiflora Mill.	
	Ephedra distachya L.	
	Epipogium aphyllum (F. W. Schmidt) Sw.	
	Equisetum ramosissimum Desf.	
	Eriophorum gracile Koch	
	Eriophorum latifolium Hoppe	
	Euphorbia rossica P. Smirn.	
	Fritillaria ruthenica Wikstr.	
	Galatella angustissima Tausch.	
	Galatella villosa (L.) Reichenb. fil.	
	Glyceria lithuanica (Gorski) Gorski	
	Hammarbya paludosa (L.) O. Kuntze	
	Helianthemum nummularium (L.) Mill.	
	Helictotrichon desertorum (Less.) Nevski	
	Helictotrichon schellianum (Hack.) Kitag.	
	Holcus mollis L.	
	Huperzia selago (L.) Bernh. ex Schrank et Mart.	
	Inula germanica L.	

Table 5. (Continued).

Category	Species	Number of species
	Koeleria spryginii Tzvelev	
	Krascheninnikovia ceratoides (L.) Gueldenst.	
	Lathyrus pallescens (Bieb.) C. Koch	
	Linum perenne L.	
	Listera cordata (L.) R. Br.	
	Malaxis monophyllos (L.) Sw.	
	Melica transsilvanica Schur	
	Orchis militaris L.	
	Pedicularis dasystachys Schrenk	
	Polygala cretacea Kotov	
	Potamogeton alpinus Balb.	
	Potamogeton praelongus Wulfen	
	Pyrola media Sw.	
	Rhynchospora alba (L.) Vahl	
	Scabiosa isetensis L.	
	Scilla sibirica Haw.	
	Scutellaria supina L.	
	Silaum silaus (L.) Schinz et Thell.	
	Silene baschkirorum Janisch.	
	Stipa dasyphylla (Lindem.) Trautv.	
	Stipa pulcherrima C. Koch	
	Stipa sareptana A. Beck.	
	Stipa zalesskii Wilensky	
	Thymus cimicinus Blum ex Ledeb.	
	Trifolium lupinaster L.	
	Tulipa biebersteiniana Schult. et Schult. fil.	
	Utricularia intermedia Hayne	
2 – Vulnerable	*Adonis vernalis* L.	62
	Allium flavescens Bess.	
	Anemone sylvestris L.	
	Arenaria biebersteinii Schlecht.	
	Artemisia armeniaca Lam.	
	Artemisia latifolia Ledeb.	
	Artemisia pontica L.	
	Artemisia sericea Web. ex Stechm.	
	Aster amellus L.	
	Astragalus arenarius L.	
	Astragalus austriacus Jacq.	
	Astragalus onobrychis L.	
	Bupleurum aureum (Hoffm.) Fisch. ex Hoffm.	
	Bupleurum falcatum L.	
	Carex limosa L.	

Category	Species	Number of species
	Carex supina Wahlenb.	
	Caulinia minor (All.) Cosson et Germ.	
	Centaurea ruthenica Lam.	
	Cephalanthera rubra (L.) Rich.	
	Coeloglossum viride (L.) Hartm.	
	Cotoneaster melanocarpus Lodd., G. Lodd. et W. Lodd.	
	Cypripedium calceolus L.	
	Dactylorhiza maculata (L.) Soó	
	Delphinium cuneatum Stev. ex DC. s. l.	
	Dianthus arenarius L.	
	Drosera rotundifolia L.	
	Echinops ritro L.	
	Elytrigia lolioides (Kar. et Kir.) Nevski	
	Galatella linosyris (L.) Reichenb. fil.	
	Gladiolus imbricatus L.	
	Goodyera repens (L.) R. Br.	
	Herminium monorchis (L.) R. Br.	
	Hieracium arcuatidens (Zahn ex Petunn.) Juxip ex Schljakov	
	Hieracium virosum Pall.	
	Hypericum elegans Steph. ex Willd.	
	Iris aphylla L.	
	Juniperus communis L.	
	Lilium martagon L.	
	Linnaea borealis L.	
	Linum flavum L.	
	Lunaria rediviva L.	
	Lycopodiella inundata (L.) Holub	
	Najas major All.	
	Neottianthe cucullata (L.) Schlecht.	
	Onosma simplicissima L.	
	Oxycoccus palustris Pers.	
	Polygala sibirica L.	
	Potentilla arenaria Borkh.	
	Pulsatilla patens (L.) Mill.	
	Salix myrtilloides L.	
	Salvinia natans (L.) All.	
	Scheuchzeria palustris L.	
	Senecio integrifolius (L.) Clairv.	
	Silene sibirica (L.) Pers.	
	Spiraea crenata L.	
	Stipa capillata L.	
	Stipa pennata L.	
	Stipa tirsa Steven	

Table 5. (Continued).

Category	Species	Number of species
	Trapa natans L. s. l.	
	Verbascum phoeniceum L.	
	Veronica spuria L.	
	Viola uliginosa Bess.	
3 – Rare	*Acer campestre* L.	31
	Carex disperma Dew.	
	Carex paupercula Michx.	
	Carex rhynchophysa C. A. Mey.	
	Carex tomentosa L.	
	Cinna latifolia (Trev.) Griseb.	
	Dipsacus pilosus L.	
	Elatine hydropiper L.	
	Epipactis palustris (L.) Crantz	
	Filago minima (Smith) Pers.	
	Galatella rossica Novopokr.	
	Galium triflorum Michx.	
	Gratiola officinalis L.	
	Gymnadenia conopsea (L.) R. Br.	
	Iris sibirica L.	
	Linaria genistifolia (L.) Mill.	
	Moneses uniflora (L.) A. Gray	
	Orobanche coerulescens Steph.	
	Orobanche elatior Sutt.	
	Pedicularis sceptrum-carolinum L.	
	Polygala wolfgangiana Bess. ex Szafer, Kulcz. et Pawł.	
	Potamogeton gramineus L.	
	Potamogeton obtusifolius Mert. et Koch	
	Ranunculus kauffmannii Clerc	
	Ranunculus polyphyllus Waldst. et Kit. ex Willd.	
	Ranunculus trichophyllus Chaix	
	Rosa rubiginosa L.	
	Salix lapponum L.	
	Scrophularia umbrosa Dumort.	
	Senecio tataricus Less.	
	Silene amoena L.	
4 – Indeterminate	*Dactylorhiza cruenta* (O. F. Muell.) Soó	4
	Orobanche pallidiflora Wimm. et Grab.	
	Pedicularis palustris L.	
	Polygala amarella Crantz	

RARE PLANTS ON PROTECTED AREAS NETWORK IN THE REPUBLIC OF MORDOVIA

At present, there are 93 Protected Areas in the Republic of Mordovia, including the Mordovia State Nature Reserve, National Park "Smolny", 90 natural landmarks and the Botanical Garden of the Mordovia State University (Vargot et al. 2015). However, the PAs Network of Mordovia is currently unrepresentative (Silaeva et al. 2009a; Khapugin and Silaeva 2013). During period of 2004–2015, 44 areas have been recommended for establishing botanical PAs to increase quality of the PAs Network of Mordovia. These are 1 natural park, 4 complex preserves and 39 natural landmarks (Vargot et al. 2015).

Table 6 shows that recommendations of 2004–2015 years will contribute to the conservation of all main groups of habitats. However, the most part of new PAs are the steppes and boreal forests in the Republic of Mordovia. This is highly correlated with results of coenotic analysis of the flora of rare species of Mordovia (Table 4). Thus, recommendations of 2004–2015 years have been aimed to protect the highest number of rare plant species populations in Mordovia.

Table 6. Number of rare plant populations located within (and outside) Protected Areas Network of Mordovia and ranked over coenotical groups of habitats

Coenotical group of habitats	Number of species populations								
	At the present stage				Recommendations of 2004–2015 years				Total within Mordovia
	Within PAs			Outside PAs	Within Pas			Outside PAs	
	MR	NP	Other PAs		MR	NP	Other PAs		
Boreal coniferous forest	195	76	21	195	195	76	390	97	487
Broad-leaved forest	26	18	8	93	26	18	42	59	145
Steppe	0	3	43	874	0	3	454	466	920
Meadow	18	0	2	53	18	0	43	30	73
Terrestrial wetland	97	34	20	139	97	34	204	86	290
Aquatic wetland	13	13	21	107	13	13	86	68	154
Total	348	145	115	1461	348	145	1261	806	2069

At present, only 508 of 2069 rare plant populations are located within existing PAs Network of Mordovia (Table 6). It should be noted that 348 of 2069 populations are located within the Mordovia State Nature Reserve, and 145 of 2069 populations are located within National Park "Smolny". It confirms the significance of these federal PAs in conservation of rare plant populations in Mordovia as well as in Central Russia as a whole.

We have carried out analysis of the representation of populations for each of rare plant species within PAs Network (Table 7). Populations of only 17 plant species are considered as completely located within the PAs Network of the Republic of Mordovia. These are 1 species with the rarity category 0 (*Diplazium sibiricum*), 11 species with the rarity category 1 (*Huperzia selago*, *Alnus incana*, *Lathyrus pallescens*, *Pedicularis dasystachys*, *Caulinia tenuissima*, *Carex chordorrhiza*, *Carex dioica*, *Avenella flexuosa*, *Holcus mollis*, *Hammarbya paludosa*, *Listera cordata*), 3 species with the rarity category 2 (*Hieracium arcuatidens*, *Bupleurum aureum*, *Viola uliginosa*), and 2 species with the rarity category 3 (*Carex paupercula*, *Cinna latifolia*).

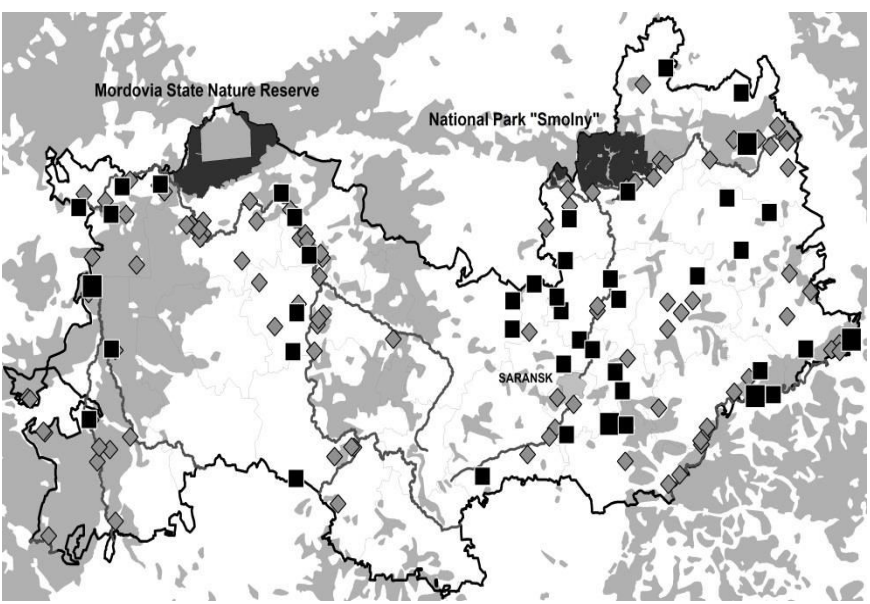

Figure 2. Existing (gray diamonds) and recommended (black squares) Protected Areas on the map of the Republic of Mordovia. Forest areas are marked by gray colour.

Table 7. Number of populations located within (or outside) the Protected Areas in Mordovia (Kuznetsov and Silaeva, 2008) and (in a case of the CATF Sarov) the Nizhny Novgorod region (Bakka and Kiseleva, 2008).

№	Species of second edition of the Red Data Book of the Republic of Mordovia	Number of species populations							
		At the present stage				Recommendations of 2004–2015 years			
		Within PAs			Outside PAs	Within PAs			Outside PAs
		MR	NP	Other PAs		MR	NP	Other PAs	
1	*Acer campestre* L.	0	0	0	23	0	0	1	22
2	*Adonis vernalis* L.	0	0	5	59	0	0	26	38
3	*Allium cretaceum* N. Friesen and Seregin	0	0	0	1	0	0	1	0
4	*Allium flavescens* Bess.	0	0	0	11	0	0	8	3
5	*Alnus incana* (L.) Moench	2	0	0	0	2	0	0	0
6	*Amygdalus nana* L.	0	0	1	3	0	0	4	0
7	*Andromeda polifolia* L.	12	0	2	7	12	0	6	3
8	*Anemone sylvestris* L.	0	0	4	39	0	0	21	22
9	*Arctostaphylos uva-ursi* (L.) Spreng.	0	0	0	1	0	0	1	0
10	*Arenaria biebersteinii* Schlecht.	0	0	0	4	0	0	4	0
11	*Artemisia armeniaca* Lam.	0	0	1	29	0	0	14	16
12	*Artemisia latifolia* Ledeb.	0	0	4	30	0	0	25	9
13	*Artemisia pontica* L.	0	0	0	26	0	0	13	13
14	*Artemisia sericea* Web. ex Stechm.	0	0	1	7	0	0	7	1
15	*Aster amellus* L.	0	0	2	37	0	0	16	23
16	*Astragalus arenarius* L.	0	0	0	3	0	0	3	0
17	*Astragalus asper* Jacq.	0	0	0	1	0	0	1	0
18	*Astragalus austriacus* Jacq.	0	0	0	16	0	0	10	6
19	*Astragalus onobrychis* L.	0	0	0	11	0	0	5	6

Table 7. (Continued)

№	Species of second edition of the Red Data Book of the Republic of Mordovia	Number of species populations							
		At the present stage				Recommendations of 2004–2015 years			
		Within PAs			Outside PAs	Within PAs			Outside PAs
		MR	NP	Other PAs		MR	NP	Other PAs	
20	*Astragalus sulcatus* L.	0	0	0	4	0	0	2	2
21	*Avenella flexuosa* (L.) Drejer	2	0	0	0	2	0	0	0
22	*Botrychium virginianum* (L.) Sw.	1	0	0	1	1	0	1	0
23	*Botrychium matricariifolium* A. Braun ex Koch	0	0	0	2	0	0	0	2
24	*Bupleurum aureum* (Hoffm.) Fisch. ex Hoffm.	0	9	0	0	0	9	0	0
25	*Bupleurum falcatum* L.	0	0	0	10	0	0	8	2
26	*Carex chordorrhiza* Ehrh.	1	0	1	0	1	0	1	0
27	*Carex dioica* L.	0	1	1	0	0	1	1	0
28	*Carex disperma* Dew.	7	1	1	4	7	1	2	3
29	*Carex flava* L.	0	0	0	1	0	0	1	0
30	*Carex hartmanii* Cajand.	0	0	0	3	0	0	2	1
31	*Carex limosa* L.	2	3	2	6	2	3	6	2
32	*Carex paupercula* Michx.	4	0	1	0	4	0	1	0
33	*Carex pediformis* C. A. Mey.	0	0	0	1	0	0	1	0
34	*Carex rhynchophysa* C. A. Mey.	3	1	0	2	3	1	0	2
35	*Carex supina* Wahlenb.	0	0	0	14	0	0	11	3
36	*Carex tomentosa* L.	0	0	0	3	0	0	1	2
37	*Caulinia minor* (All.) Cosson et Germ.	0	2	3	8	0	2	5	6
38	*Caulinia tenuissima* (A. Br.) Tzvelev	0	0	1	0	0	0	1	0

№	Species of second edition of the Red Data Book of the Republic of Mordovia	Number of species populations							
		At the present stage				Recommendations of 2004–2015 years			
		Within PAs			Outside PAs	Within PAs			Outside PAs
		MR	NP	Other PAs		MR	NP	Other PAs	
39	*Centaurea ruthenica* Lam.	0	0	1	6	0	0	6	1
40	*Cephalanthera rubra* (L.) Rich.	3	0	1	6	3	0	6	1
41	*Cinna latifolia* (Trev.) Griseb.	3	3	0	0	3	3	0	0
42	*Clematis recta* L.	0	0	0	1	0	0	1	0
43	*Coeloglossum viride* (L.) Hartm.	0	0	0	1	0	0	1	0
44	*Corallorhiza trifida* Chatel.	4	1	0	3	4	1	1	2
45	*Cotoneaster melanocarpus* Lodd., G. Lodd. et W. Lodd.	0	1	2	2	0	1	3	1
46	*Cypripedium calceolus* L.	3	0	3	14	3	0	12	5
47	*Cypripedium guttatum* Sw.	0	0	0	1	0	0	1	0
48	*Dactylorhiza cruenta* (O. F. Muell.) Soó	0	0	0	2	0	0	2	0
49	*Dactylorhiza maculata* (L.) Soó	6	0	0	3	6	0	1	2
50	*Delphinium cuneatum* Stev. ex DC. s. l.	0	0	1	25	0	0	9	17
51	*Dianthus arenarius* L.	0	0	2	19	0	0	17	4
52	*Digitalis grandiflora* Mill.	0	0	0	3	0	0	0	3
53	*Diplazium sibiricum* (Turcz. ex C. Kunze)	1	0	0	0	1	0	0	0
54	*Dipsacus pilosus* L.	0	0	0	2	0	0	0	2
55	*Drosera rotundifolia* L.	7	8	2	20	7	8	8	14
56	*Echinops ritro* L.	0	0	0	49	0	0	7	42
57	*Elatine hydropiper* L.	0	0	1	8	0	0	3	6
58	*Elytrigia lolioides* (Kar. et Kir.) Nevski	0	0	0	9	0	0	5	4

Table 7. (Continued)

№	Species of second edition of the Red Data Book of the Republic of Mordovia	Number of species populations							
		At the present stage				Recommendations of 2004–2015 years			
		Within PAs			Outside PAs	Within PAs			Outside PAs
		MR	NP	Other PAs		MR	NP	Other PAs	
59	*Ephedra distachya* L.	0	0	0	1	0	0	1	0
60	*Epipactis palustris* (L.) Crantz	0	0	0	6	0	0	2	4
61	*Epipogium aphyllum* (F. W. Schmidt) Sw.	0	0	0	3	0	0	1	2
62	*Equisetum ramosissimum* Desf.	0	0	0	1	0	0	1	0
63	*Eriophorum gracile* Koch	0	1	1	4	0	1	2	3
64	*Eriophorum latifolium* Hoppe	1	1	0	2	1	1	1	1
65	*Euphorbia rossica* P. Smirn.	0	0	0	3	0	0	2	1
66	*Filago minima* (Smith) Pers.	0	0	0	2	0	0	0	2
67	*Fritillaria ruthenica* Wikstr.	0	0	0	2	0	0	1	1
68	*Galatella angustissima* Tausch.	0	0	0	2	0	0	2	0
69	*Galatella linosyris* (L.) Reichenb. fil.	0	0	0	11	0	0	8	3
70	*Galatella rossica* Novopokr.	0	0	0	7	0	0	3	4
71	*Galatella villosa* (L.) Reichenb. fil.	0	0	0	1	0	0	1	0
72	*Galium triflorum* Michx.	3	0	0	1	3	0	0	1
73	*Gladiolus imbricatus* L.	0	0	0	7	0	0	3	4
74	*Glyceria lithuanica* (Gorski) Gorski	12	0	0	1	12	0	0	1
75	*Goodyera repens* (L.) R. Br.	12	0	1	2	12	0	1	2
76	*Gratiola officinalis* L.	5	0	0	8	5	0	2	6
77	*Gymnadenia conopsea* (L.) R. Br.	5	0	0	5	5	0	1	4
78	*Hammarbya paludosa* (L.) O. Kuntze	0	1	0	0	0	1	0	0

№	Species of second edition of the Red Data Book of the Republic of Mordovia	Number of species populations							
		At the present stage				Recommendations of 2004–2015 years			
		Within PAs			Outside PAs	Within PAs			Outside PAs
		MR	NP	Other PAs		MR	NP	Other PAs	
79	*Helianthemum nummularium* (L.) Mill.	0	0	0	1	0	0	1	0
80	*Helictotrichon desertorum* (Less.) Nevski	0	0	0	5	0	0	4	1
81	*Helictotrichon schellianum* (Hack.) Kitag.	0	0	0	10	0	0	8	2
82	*Herminium monorchis* (L.) R. Br.	0	0	0	6	0	0	1	5
83	*Hieracium arcuatidens* (Zahn ex Petunn.) Juxip ex Schljakov	1	0	0	0	1	0	0	0
84	*Hieracium virosum* Pall.	0	0	0	5	0	0	5	0
85	*Holcus mollis* L.	1	0	0	0	1	0	0	0
86	*Huperzia selago* (L.) Bernh. ex Schrank et Mart.	2	2	0	0	2	2	0	0
87	*Hypericum elegans* Steph. ex Willd.	0	0	2	17	0	0	11	8
88	*Inula germanica* L.	0	0	1	1	0	0	2	0
89	*Iris aphylla* L.	0	1	3	41	0	1	29	15
90	*Iris sibirica* L.	5	0	1	17	5	0	5	13
91	*Juniperus communis* L.	39	18	5	50	39	18	38	17
92	*Koeleria spryginii* Tzvelev	0	0	0	2	0	0	1	1
93	*Krascheninnikovia ceratoides* (L.) Gueldenst.	0	0	0	2	0	0	2	0
94	*Lathyrus pallescens* (Bieb.) C. Koch	0	0	1	0	0	0	1	0
95	*Lilium martagon* L.	0	0	3	30	0	0	15	18
96	*Linaria genistifolia* (L.) Mill.	0	0	0	3	0	0	0	3
97	*Linnaea borealis* L.	35	17	0	20	35	17	4	16
98	*Linum flavum* L.	0	0	4	18	0	0	13	9

Table 7. (Continued)

№	Species of second edition of the Red Data Book of the Republic of Mordovia	Number of species populations							
		At the present stage				Recommendations of 2004–2015 years			
		Within PAs			Within PAs	Within PAs			Within PAs
		MR	NP	Other PAs		MR	NP	Other PAs	
99	*Linum perenne* L.	0	0	0	3	0	0	3	0
100	*Listera cordata* (L.) R. Br.	2	0	0	0	2	0	0	0
101	*Lunaria rediviva* L.	8	5	0	1	8	5	0	1
102	*Lycopodiella inundata* (L.) Holub	1	0	0	2	1	0	1	1
103	*Malaxis monophyllos* (L.) Sw.	4	0	1	2	4	0	3	0
104	*Melica transsilvanica* Schur	0	0	0	2	0	0	2	0
105	*Moneses uniflora* (L.) A. Gray	6	2	1	7	6	2	4	4
106	*Najas major* All.	0	3	3	11	0	3	5	9
107	*Neottianthe cucullata* (L.) Schlecht.	9	15	0	1	9	15	1	0
108	*Onosma simplicissima* L.	0	0	0	9	0	0	7	2
109	*Orchis militaris* L.	0	0	1	7	0	0	7	1
110	*Orchis ustulata* L.	0	0	0	1	0	0	0	1
111	*Orobanche coerulescens* Steph.	0	0	1	1	0	0	2	0
112	*Orobanche elatior* Sutt.	0	0	0	3	0	0	3	0
113	*Orobanche pallidiflora* Wimm. et Grab.	0	1	0	1	0	1	1	0
114	*Oxycoccus palustris* Pers.	23	12	4	44	23	12	17	31
115	*Pedicularis dasystachys* Schrenk	2	0	0	0	2	0	0	0
116	*Pedicularis palustris* L.	1	1	0	2	1	1	2	0
117	*Pedicularis sceptrum-carolinum* L.	0	0	0	3	0	0	2	1
118	*Polygala amarella* Crantz	0	0	0	1	0	0	0	1

№	Species of second edition of the Red Data Book of the Republic of Mordovia	Number of species populations							
		At the present stage				Recommendations of 2004–2015 years			
		Within PAs			Within PAs	Within PAs			Within PAs
		MR	NP	Other PAs		MR	NP	Other PAs	
119	*Polygala cretacea* Kotov	0	0	0	1	0	0	1	0
120	*Polygala sibirica* L.	0	0	1	15	0	0	8	8
121	*Polygala wolfgangiana* Bess. ex Szafer, Kulcz. et Pawł.	2	0	0	2	2	0	1	1
122	*Potamogeton alpinus* Balb.	4	0	0	4	4	0	0	4
123	*Potamogeton gramineus* L.	0	1	1	13	0	1	8	6
124	*Potamogeton obtusifolius* Mert. et Koch	5	1	1	7	5	1	5	3
125	*Potamogeton praelongus* Wulfen	1	0	2	3	1	0	2	3
126	*Potentilla arenaria* Borkh.	0	0	2	10	0	0	11	1
127	*Pulsatilla patens* (L.) Mill.	77	20	9	63	77	20	28	44
128	*Pyrola media* Sw.	5	1	0	3	5	1	1	2
129	*Ranunculus kauffmannii* Clerc	0	0	0	7	0	0	0	7
130	*Ranunculus polyphyllus* Waldst. et Kit. ex Willd.	0	0	0	5	0	0	2	3
131	*Ranunculus trichophyllus* Chaix	1	0	0	7	1	0	1	6
132	*Rhynchospora alba* (L.) Vahl	0	0	0	1	0	0	0	1
133	*Rosa rubiginosa* L.	0	0	0	9	0	0	2	7
134	*Salix lapponum* L.	1	0	1	9	1	0	4	6
135	*Salix myrtilloides* L.	0	0	1	9	0	0	6	4
136	*Salvinia natans* (L.) All.	0	0	2	13	0	0	13	2
137	*Scabiosa isetensis* L.	0	0	0	1	0	0	1	0
138	*Scheuchzeria palustris* L.	4	3	1	2	4	3	3	0

Table 7. (Continued)

№	Species of second edition of the Red Data Book of the Republic of Mordovia	Number of species populations							
		At the present stage				Recommendations of 2004–2015 years			
		Within PAs			Within PAs	Within PAs			Within PAs
		MR	NP	Other PAs		MR	NP	Other PAs	
139	*Scilla sibirica* Haw.	0	0	1	1	0	0	2	0
140	*Scrophularia umbrosa* Dumort.	0	0	1	6	0	0	5	2
141	*Scutellaria supina* L.	0	0	0	1	0	0	1	0
142	*Senecio integrifolius* (L.) Clairv.	0	0	0	4	0	0	2	2
143	*Senecio tataricus* Less.	5	0	0	5	5	0	3	2
144	*Silaum silaus* (L.) Schinz et Thell.	0	0	0	1	0	0	1	0
145	*Silene amoena* L.	0	0	0	7	0	0	1	6
146	*Silene baschkirorum* Janisch.	0	0	0	1	0	0	1	0
147	*Silene sibirica* (L.) Pers.	0	0	0	7	0	0	4	3
148	*Silene steppicola* Kleopov	0	0	0	1	0	0	0	1
149	*Spiraea crenata* L.	0	0	1	15	0	0	10	6
150	*Stipa capillata* L.	0	0	1	40	0	0	14	27
151	*Stipa dasyphylla* (Lindem.) Trautv.	0	0	0	3	0	0	3	0
152	*Stipa pennata* L.	0	0	4	153	0	0	39	118
153	*Stipa pulcherrima* C. Koch	0	0	0	3	0	0	3	0
154	*Stipa sareptana* A. Beck.	0	0	0	6	0	0	4	2
155	*Stipa tirsa* Steven	0	0	0	14	0	0	10	4
156	*Stipa zalesskii* Wilensky	0	0	0	4	0	0	4	0
157	*Thymus cimicinus* Blum ex Ledeb.	0	0	2	2	0	0	4	0
158	*Trapa natans* L. s. l.	2	5	6	15	2	5	12	9

№	Species of second edition of the Red Data Book of the Republic of Mordovia	Number of species populations							
		At the present stage				Recommendations of 2004–2015 years			
		Within PAs			Within PAs	Within PAs			Within PAs
		MR	NP	Other PAs		MR	NP	Other PAs	
159	*Trifolium lupinaster* L.	0	0	0	2	0	0	2	0
160	*Tulipa biebersteiniana* Schult. et Schult. fil.	0	1	0	1	0	1	0	1
161	*Utricularia intermedia* Hayne	0	2	1	6	0	2	3	4
162	*Verbascum phoeniceum* L.	0	0	1	29	0	0	13	17
163	*Veronica spuria* L.	0	0	0	12	0	0	7	5
164	*Viola uliginosa* Bess.	2	1	0	0	2	1	0	0
Total:		348	145	115	1461	348	145	770	807

The establishment of 44 new botanical PAs in Mordovia will contribute to conservation another 655 (31.8%) rare plant populations located outside PAs Network of Mordovia at present (Table 7). The inclusion of these new areas into the PAs Network will allow cover all of the known plant populations for 58 rare species of the Republic Mordovia. These are 1 species with the rarity category 0 (*Diplazium sibiricum*), 41 species with the rarity category 1 (*Ephedra distachya*, *Krascheninnikovia ceratoides*, *Arctostaphylos uva-ursi*, *Thymus cimicinus*, *Caulinia tenuissima*, etc.), 9 species with the rarity category 2 (*Arenaria biebersteinii*, *Hieracium arcuatidens*, *H. virosum*, *Astragalus arenarius*, *Bupleurum aureum*, *Viola uliginosa*, *Coeloglossum viride*, *Neottianthe cucullata*, *Scheuchzeria palustris*), 4 species with the rarity category 3 (*Orobanche coerulescens*, *Orobanche elatior*, *Carex paupercula*, *Cinna latifolia*), 3 species with the rarity category 4 (*Orobanche pallidiflora*, *Pedicularis palustris*, *Dactylorhiza cruenta*).

Even establishment of all PAs, recommended in 2004–2015, will not allow to cover no one population for 9 rare plant species. These are 3 species with the rarity category 0 (*Botrychium matricariifolium*, *Silene steppicola*, *Orchis ustulata*), 1 species with the rarity category 1 (*Digitalis grandiflora*), 4 species with the rarity category 3 (*Filago minima*, *Dipsacus pilosus*, *Ranunculus kauffmannii*, *Linaria genistifolia*), and 1 species with the rarity category 4 (*Polygala amarella*). Almost all these plants are single rare species in their localities. Therefore the establishment of new PAs in these locations would be inexpedient. The exclusion is the *Polygala amarella* which grows together with *Orchis militaris* and *Epipactis palustris* in its location. This location is situated within the working settlement Komsomolskiy. So protection of this location can not be organised in this case.

Rational arrangement of PAs plays an important role in building of environmental management within certain territory. The effectiveness of the PAs Network depends on the following factors: i) the largest number of habitats represented in PAs; ii) homogeneous arrangement of PAs across the territory; iii) maximum number of species represented in the PAs Network. In this case, the last (iii) point is an important factor in justifying the establishment of a new PA. The first two points (i, ii) are determined by the researchers in certain region. Of course, primarily the highest efficiency of the PAs Network will be provided, if all habitat types are covered by PAs. Thus relict and rare habitats (outputs limestone, undisturbed boreal forests, etc.) must be primarily included in the PAs Network. Compliance with paragraph (i) will entail the implementation of point (ii) only under conditions of low level of vegetation cover disturbance in certain territory. Point ii would be less

mandatory for the PAs Network in conditions of the high level of disturbance of natural habitats.

Figure 2 shows that existing PAs (gray diamonds) are distributed very unevenly across the territory of Mordovia. The large percentage of existing PAs is confined to the riverbeds and floodplains of the main rivers of Mordovia: Sura, Moksha, Insar, Alatyr. Thus, significant areas in central, forest-covered western and steppe eastern parts of a region are completely free of existing PAs. However, within these “blank spaces” there are many low-disturbed natural habitats with participation of rare plant species. Areas, which have been recommended for the organisation of botanical PAs during the period of 2004–2015 (black squares), are concentrated mainly in the eastern Mordovia. Most of these are the steppe habitats (Table 6), located exactly in eastern part of region. Unfortunately, western part of Mordovia is still relatively free of PAs.

Thus, at present there are two large federal PAs in the Republic of Mordovia. These are the Mordovia State Nature Reserve and National Park "Smolny". They have the special protection regime and they contribute to conservation of 23.8% of rare plant populations, including 49.8% of forest plant species. However, the existing PAs Network of Mordovia is still unrepresentative. The largest “blank spaces” are located in western and central parts of a region; although these are exist in eastern Mordovia too. Establishing of new botanical PAs will allow increasing the number of protected populations from 29.4% to 61.0% of total their number. This increasing would be especially large in case of steppe plants. Number of steppe plants within the PAs Network in Mordovia would be increased in almost 10 times (from 46 to 457 populations). In relation to other coenotical groups of rare plants, the number of populations within the PAs Network would be also increased. In general, it can be said that federal PAs (Mordovia State Nature Reserve and National Park “Smolny”) play important role in conservation of plant populations of mainly forest and wetland species; while other PAs (including those recommended in 2004–2015) contribute to the conservation of plant populations of mainly steppe, meadow, aquatic species.

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