Decentralizing Institutions for Forest Conservation in Kenya: Comparative Analysis of Resource Conservation Outcomes under National Park and Forest Reserve Regimes in Mt. Elgon Forest Ecosystem.

Esther Mwangi[1], Paul Ongugo[2] and Jane Njuguna[2].

Abstract:

This study views decentralization of forest management as a continuum in which property rights to forest resources are transferred away from central governments or forest departments to local communities (Agrawal and Ostrom, 1999). We compare the rights user groups have to forest resources in the Mt. Elgon National park with that to users in the Mt. Elgon Forest Reserve, and the incentives that each type of rights engenders towards forest resource conservation. We find that in the Forest Reserve, which in our construction represents a decentralized management, local community involvement in decision-making and in rule crafting and enforcement resulted in positive incentives for forest conservation. Forest condition in the Forest Reserve was found to be better than in the National Park. The National Park's policy by forbidding local consumptive use of resources and excluding local populations from making resource-related, engendered animosity and considerable conflicts with the local populations. This created disincentives to local communities that are reflected in the condition of the forest. Decentralized decision-making, in this case, appears to be associated with better forest conservation outcomes.

[1] Workshop in Political Theory and Policy Analysis, Indiana University.
[2] Kenya Forestry Research Institute.

Introduction:

The state's dismal performance in delivering development is under increased scrutiny. Over 30 years of centralized state governance in Kenya and elsewhere in Africa has demonstrated that concentrating powers in the hands of the state might not have been the best choice for development. Instead, increasing demand, both domestic and international, for greater community participation in governance accompanies the decline in state capacities.

Decentralizing decision-making is once again gaining currency in Kenya, much as it did in the 1960s and 70s. Past decentralization efforts in Kenya focused on promoting central government administrative efficiency. Such measures were essentially a delegation of administrative authority by central government to regional arms of the government. There was no devolution of powers to field officers, neither was there a conscious effort to incorporate local communities in decision-making.

In Africa natural resource management and conservation has historically been the responsibility of the central government. Yet this administrative strategy has failed to protect resources and to integrate and develop rural economies. Scholars show that governments are not necessarily better or more successful managers of resources (Gibson et al, 1999). Local communities have been successful too. Current thinking among scholars and conservationists favor decentralized, community-based approaches as an alternative. Lutz and Caldecott (1996) find that decentralization improves conservation and management of natural resources while Ostrom's (1990) extensive analysis of varied cases from different parts of the world demonstrates that local institutions play a key role in managing ecosystems and conserving biodiversity.

Despite claims that decentralization yields benefits such as equity, administrative efficiency, resource conservation, etc., some scholars still argue that little empirical evidence exists to justify decentralization as a generalized strategy (Lutz and Caldecott,1996; Agrawal and Ribot, 1999 ;and Agrawal and Ostrom, 1999). The effects of decentralized decision-making on measurable resource outcomes, for example, are still unclear and variable.

In this study we attempt to demonstrate the comparative effects of varying degrees of decentralized decision-making on forest condition in Mt. Elgon National Park and Mt Elgon Forest Reserve in Kenya. Both Mt. Elgon National park and Mt. Elgon Forest Reserve are part of the Mt. Elgon forest ecosystem on the border of Kenya and Uganda. Mt. Elgon Forest Reserve, here onwards referred to as Forest Reserve, is managed by the Forest Department of the Ministry of Environment and Natural Resources. Mt. Elgon National Park, here onward referred to as National Park, is managed by the Kenya Wildlife Service. Forest reserve management policy is flexible and permits local community use of resources. National Park policy on the other hand, forbids community harvesting of resources. Individuals found harvesting resources are viewed as public offenders subject to fines or prosecution. The Park relies extensively on policing by park rangers to enforce this policy.

We begin our analysis with the premise that decentralization is a continuum (Agrawal and Ostrom, 1999; Uphoff, 1997) and that in forest management it is determined by the degree to which the state relinquishes property rights over forest

resources to local communities. We thus compare forest resource outcomes in the Forest Reserve characterized by flexible and somewhat decentralized management system to resource outcomes in the National Park that is characterized by a rigid and highly centralized management policy. We argue that decentralized decision-making, in which local communities are involved in creating and enforcing local rules on forest resources harvesting, yield better resource conservation outcomes than a restricted National Park model which excludes community involvement, and which relies heavily on policing.

In the following sections we provide an overview of the decentralization discourse as it applies to forest management. We describe our analytical framework. We describe our study area, providing an indication of community involvement in resource use and management in both Forest Reserve and National Park, and the types of conflicts present. We finally discuss our methods and results of our analysis.

Decentralization, Institutions and Natural Resource Management:

Many analysts agree that decentralization is not a single thing, but covers different kinds of decision-making arrangements or solution sets intended to solve a variety of problems. In their arguments supporting decentralization, scholars and practitioners identify the potential of decentralization to promote more rapid, equitable and sustainable rural development. They see decentralization as a critical strategy for rectifying the asymmetry between knowledge and information (Uphoff, 199*). Those persons with knowledge about particular problems generally have the least authority to do something about them, while those with authority commonly lack a concrete understanding of the situations, which they are trying to improve. Decentralization increases proximity between local actors and decision-makers, making it easier to access local skills and information, thereby reducing management and transactions costs (Agrawal and Ribot, 1999).

In the area of natural resource management decentralization offers the potential of increased responsiveness to local concerns, respect for local traditions and the use of local knowledge, more equal sharing of the benefits of conservation i.e. specific reward linked to the conservation value of natural resources close to local populations. Some analyst's however quote instances in which decentralization has served to strengthen government power. Hill's (1996) analysis of Zimbabwe's wildlife utilization program finds that decentralization of natural resources was a successful attempt to recentralize government authority where official presence has heretofore been limited.

Decentralizing natural resource management might improve the conservation and management of natural resources (Lutz and Caldecott, 1996). Empowered local institutions that were given authority and control over revenues and expenditure decisions also had more effective control over management of natural resources. In addition, community based resource management is generally successful where members are able to organize and carry out basic functions themselves, including the establishment of use rules and regulations, the resolution of disputes, the monitoring of resource use practices, the imposition of sanctions against offenders and the equitable distribution of benefits. Such decentralization has been linked to protected areas through Integrated Conservation Development Projects or ICDPs (Wells and Brandon, 1992). ICDPs strengthen local institutions as a way of creating incentives for conservation among local stakeholders.

Several comparative studies have recently examined the practical implications of improving local incentives for conservation including Kiss (1990), West and Brechin (1991), Wells and Brandon (1992), IIED (1994), and Western and Wright (1994). While these studies demonstrate greater involvement of communities, they fail to show empirically how this involvement translates into better-conserved ecosystems. Lutz and Caldecott (1996) in fact identify the dangers of decentralizing authority to local institutions. Local elite for instance could capture resources and use the decentralization process to further their own short-term private interests.

Agrawal and Ribot (1999) suggest a framework for analyzing the extent of decentralization under varying circumstances. A clear conception of the powers of actors, the domains in which actors exercise their powers, and to whom and how they are accountable are basic to this framework. Citing cases from India, Nepal and West Africa, they demonstrate that power by local government to enforce decisions, and downward accountability of locally empowered actors are necessary conditions for effective decentralization.

In forest management the interactions of power and property rights provide an important link between decentralization and institutions (Agrawal and Ostrom, 1999). The devolution of forest management and control implies the transfer of some types of rights away from central governments, towards more locally based organizations. This approach sees decentralization of forest management as a continuum. At one end, national governments, in response to a variety of political forces, relax their control sufficiently to allow local users sufficient rights corresponding to the proprietor. At another end are the initiatives that permit users greater rights of access and use (authorized entrant and user), but few claimant or proprietor rights. In the middle would be a host of other situations in which local residents may be allowed some managerial or decision-making rights, or rights to determine whether others can access the forest.

We find this approach appropriate to our study. Conceptualizing decentralization as a continuum permits a dynamic analysis of the influence of protected area management regimes on conservation outcomes. The notion of property rights and types of rights devolved to local populations clearly specifies the variables of interest, and accurately captures the institutional contrasts between Forest Reserve and National Park regimes in Mt. Elgon forest.

The Mount Elgon Ecosystem:

Mt. Elgon, the third highest mountain in Africa, is a solitary extinct volcano situated on the Kenya-Uganda border, about 100 km Northeast of Lake Victoria. The crater rim reaches 4320m with an overall slope of 4%. Rainfall in Mt. Elgon is experienced from April, the beginning of the rainy season, through to October.

The vegetation on Mt. Elgon exhibits distinct altitudinal zonation, comprising of mixed montane forests at lower levels below 2500m, bamboo forests in the middle reaches between about 2400-3000m and an upper zone of afro-alpine moorland vegetation above 3500m. Local variations in topography, slope, aspect and soil depth to a large extent impose some variation in vegetation composition. The southern and western slopes of the mountain in Uganda support a montane forest dominated by *Prunus africana*, *Aningeria adolfi-friedericii* and *Olea welwitschii*, while the drier northern and

eastern slopes in Kenya support a coniferous forest dominated by *Podocarpus gracilior, Juniperus procera* and *Ekebergia capensis*.

Animal life is varied and comprises of 144 bird species, diurnal forest primates, 36 species of forest butterflies and various species of small and large mammals such as elephants, buffaloes, duikers, forest hog, waterbuck, reedbuck, bushbuck, leopard etc. Elephants and leopards are of special concern due to their threatened/endangered status. Mt. Elgon represents the western limits of species/races known to occur in the Eastern African highlands.

The major factor, which justifies Mt. Elgon's protection status, is its importance as a catchment area for Lake Kyoga in Uganda and Lake Turkana in Kenya. Uganda rivers originating from Mt. Elgon include Bukwa, Siti, Kaplegep, Sipi and Lwakaka, while in Kenya rivers Suam, Kimothon, Sosio, Laboot, Kabeywan and Rongai originate from the mountain. Little is known on the biodiversity status of the Elgon ecosystem however it is home to threatened animal species and endemic plant species. The ecosystem is also important to local communities both materially from supply of forest products and culturally e.g. for circumcision rites.

In Kenya, the Mt. Elgon ecosystem assumes a dual protection status of National park and Forest reserve.

Mt. Elgon Forest Reserve:

The mount Elgon Forest Reserve covers both natural forest that is periodically subject to livestock grazing, and exotic tree plantations. The total area under forest is 10, 243 hectares; with natural forest occupying 8012 hectares and plantation forest 2123 ha and bamboo forest 1072 hectares. Three most common ethnic groups are the Sabaot (40%), Luhya (30%) and kalenjin (20%). The closest settlement to forest edge is the Chepkengen settlement, which is about 3 Km from the forest and is settled by about 2000 people.

Several user groups are known to use the forest in various ways:

The herdsmen user group comprises about 20 males all of who own at least fifteen cattle as well as some agricultural land. Some also lease land from the forest department at a fee of KShs. 300 per acre per year ($5). In addition to being herders members of this user group are non-resident forest cultivators as well. The herding user group does not engage in any forest improvement activity such as planting seedlings, or removing encroachments or creating tree nurseries. However all individuals participate in rule making and have had few to no issues that engender conflict among them. Herdsmen user group is mainly interested in livestock fodder, chiefly Kikuyu grass. Water is the second most important resource for the herdsmen. *Mimusops bagshawei* is also an important fodder species favored by herdsmen. The herdsmen try to limit their use of this forest by moving to other forests, particularly private forests. There is a certain degree of complementary interactions between herders and non-resident cultivators. After non-resident cultivators have harvested their maize crop they allow herdsmen to feed their livestock on the maize stubble.

Non-resident cultivators form the next group of forest users. They total about 400 individuals or 150 households, 380 of who are male and 20 female. Most non-resident cultivators own land, but this land is not sufficient to meet their subsistence needs and therefore these families lease land from the forest department. Some non-resident cultivators are fire wood collectors. This user group however hardly engages in forest improvement activities, though many do engage in bee-keeping activities as a way of minimizing dependency on forest products. Most individuals participate in rule making, with the exception of women who are culturally restricted from participating. Ethnic tensions between the Luhyas and Sabaot sometimes interfere with rule making. The effects of the 1991 ethnic clashes are still felt by some who feel that forest resources should not be shared equally. The Sabaots feel they are indigenous to the area and therefore entitled to a larger share of the resources.

Firewood collectors group comprises about 1200 individuals with 1000 females, 20 children and 50 males. Most members of this group are women who work on their husbands' farms. Firewood collectors also belong to the non-resident cultivators group and to grazers as well. Firewood collectors do not engage in any forest improvement activity. Although the group comprises mostly women, it appears as though very few of them engage in rule making, most of which is left to men. This user group is also affected by the ethnic tensions between Luhyas and Sabaots, however no conflicts have been recorded in recent years. Most important species for the firewood collectors group is *Olea africana*, second is *Juniperus procera*, and third is *Teclea simplicifolia*. Most users in this group feel that the level of conservation in the forest is too lax, and that if harvesting continues at the same rate, forest sustainability will be undermined. Closet substitutes are Juniperus procera, Cupressus, Pine and maize cobs. This substitutes easily available in the forest. There are restrictions on the quantity of the product that can be harvested.

The pole collectors user group. Although the group does not plant seedlings/trees/bushes or build protective barriers within the forest the group has been active in forest maintenance activities such as clearing forest encroachments, or in activities intended to reduce pressure on forest resources such as creation of tree nurseries, adopting use of more efficient woodstoves, or investing in bee keeping. The group has also maintained active contact with external authorities. Although a few of the group members participate in rule making, there have not in recent times been conflicts among group members. Species utilized is *Juniperus procera*. Pole cutting is a male activity.

Although there don't seem to be specific rules restricting entry into the forest, there are rules governing the harvesting of forest resources. Firewood collectors for example must purchase a monthly permit to harvest firewood, and even to graze animals. Water, medicinal herbs and honey harvesting are not restricted to any of the settlement's residents. Non-resident cultivators purchase an annual permit to cultivate open forestland. No hunting is allowed, and there is restricted entry into the forest for craft items.

User groups in the forest reserve area have rules that guide the monitoring and maintenance of the forest. There are rules that govern when and where fires may be started, infrastructure improvements, types of seeds or seedlings that can be planted, and

weeding methods. Verbal chastisement, temporary restrictions on harvesting and discretionary decision by government office are some of the sanctions levied on rule breakers. Appropriate penalties are however decided by forest guards, foresters, and judge in courts or government official in an administrative setting. This is not unusual because the government "owns" the forest reserve. All fines imposed are collected by forest department officials and flow into the national government's revenue coffers.

The forester's appraisal of the forest is that vegetation is abundant, and species diversity is somewhat high. The commercial value of the forest is however below normal. The most serious problems confronting the forest reserves are illegal harvesting and overexploitation of commercial tree species that are of high value in the natural forest for charcoal burning and other uses. Plantation harvesting without re-establishment is yet another problem. Forest fires are very common, and have resulted in the dominance of pioneer species in some parts of the forest. Excessive grazing and encroachment by users has and is continuing to interfere with the natural regeneration of many species. Forester finds the local communities very cooperative and sees opportunities for greater interactions in the future. He also believes that re-introduction of the non-resident cultivation system will increase food production.

The Forester however notes that over the past five years tree density and ground cover has decreased, while density of shrubs has increased. Decrease of tree density is due to clear cutting of plantation forest without replanting, illegal harvesting of valued tree species and uncontrolled forest fires. Reasons for decreasing shrub density are largely fires. Decrease in ground species is largely due to excessive grazing.

Mt. Elgon National Park:

About 5000 individuals live less than 5 Km from the forest's edge. The community is organized into the following user groups:

Firewood collectors. This comprises about 3000 individuals, constituted of 2950 females, 50 males and 50 children. 80% of the members farm on their husbands land and the remaining farm on land rented from large-scale farm owners. All individuals are involved in rule making. However, the firewood users have had several nasty confrontations with the Kenya Wildlife Service. KWS forbids firewood collection in the National park. The conflicts keep escalating each year. Major species used are *Teclea nobilis* and *Olea africana*. Medicinal use of *Prunus africana* is also important.

Hunters. This group is composed of 30 males. Most are carpenters or house builders or provide casual labor during planting either in forests or in farms. They do not engage in forest improvement activities but they do engage in activities such as bee keeping that are designed to reduce dependency on forest products. No individual in this group makes any rules regarding forest use. Only KWS does. The wildlife Act does not permit hunting of any form. These hunters are thus breaking law according to the Act and run into persistent problems with KWS officials. However, the hunters feel that they have a right to hunt in the forest since they have depended on the forest as a source of meat for many generations.

Pole cutters. Comprises 300 males. Most pole cutters are peasant farmers with an average holding of 2-3 acres. Some rent land from nearby large-scale landowners to supplement their agricultural production. Forestland is also available for non-resident cultivation. Some members are engaged as casual workers in large-scale farms and forests. They sometimes plant seedlings and trees i.e. undertake low level of forest improvement activities. Some individuals do not participate in rule making. Certain issues have created conflict within the group. Although this is within National park, the nature of the conflict is such that some members do not pay the required fees. This creates resentment and animosity from those that do pay. Major species used are *Juniperus procera*, *Olea Africa* and *Teclea nobilis*. Their main area of concern is the insecurity caused by cattle rustlers and frequent fires. Pole cutters see greatest opportunity as the promotion of farm forestry to reduce demand on the forest for most products. Shift to other alternative sources of construction materials such as stones would also be helpful.

Water collectors. This group comprises 2700 individuals, 1400 females and 1300 males. Most are farmers and livestock keepers. They do not engage in much forest improvement activities, but do try to engage in activities that reduce pressure on forests for example adoption of alternative technology and bee keeping. These user group faces a high and escalating conflict with the KWS, which regards all water users as illegal users. KWS does not allow entry into the forest for any reason, and water harvesters are supposed to draw water from the forest edges or from streams that pass near their homes.

Medicine collectors. There are 8 individuals in this group; five females and three male. All members combine medicine harvesting with farming or livestock keeping. They do not engage in forest improving activities, however, they have reduced medicinal plant harvesting in recent years in order to reduce pressure on forest.Their main conflict is with the KWS, which regards them as illegal destroyers of biological diversity, and pressurise them to stop harvesting. The forest department and district administration views them with suspicion, labelling them as collaborators with cattle rustling. Main species used are *Teclea simplicifolia* and *Prunus africana.*

Honey collectors. This group comprises of 10 males. They do not engage in forest improvement activity, but do adopt other technology and bee keeping as ways that reduce pressure on forest. KWS makes the rules with regard to honey collection. KWS feels that honey collectors are responsible for frequent forest fires and that they are wildlife poachers and collaborators with cattle rustlers.

The forester assesses the National par forest as having about normal vegetation density and species diversity. Commercial and subsistence value of forest is assessed as below normal. Tree density is decreasing due to clearing, forest fires, big game destruction, and tree destruction by medicine harvesters. Ground cover has increased over time due to rapid and vigorous regeneration following forest fires. Forest area has remained the same for a long time. He sees the most serious problems as lack of clear policies on resource utilization; conflicting legislative and sectoral arrangements, insecurity, and that the Wildlife Act does not provide opportunities for the local community to use National Park

resources. He sees the greatest opportunity for improving forest conservation and management as lying in increasing community participation and in integrating the different agencies in management and conservation efforts.

Method:

The question our study seeks to answer is: how does a decentralized, flexible and community-involving management regime characteristc of the Forest Reserve affect forest condition as compared with a rigid, community excluding and policing regime that is characteristic of the National park?

We anticipate that forest condition will be better (eg. Trees larger in number and size) in the Forest Reserve than in the National Park. Agrawal and Ostrom (1999) suggest that a decentralized system in which local communities posess bundlkes of rights associated with claimant or proprietorship, and in which users themselves are involved in the design and enforcement of rules, will likely create incentives that will encourage them to take long term benefits as well as short term costs into account when making decisions. Such conditions appear to exist in the Forest Reserve, but are absent in the National Park.

Forest condition can be approximated by measuring the size of trees, their numbers or their composition. We shall approximate forest condition by measuring the size of trees. Tree size is a continuous variable measured by measuring the length, in centimeters, of tape that goes round the trunk of a tree at about 1.3 meters above the ground. This makes up the dbh or diameter at breast height of a tree. A tree is any woody plant greater than 5meters in height, having a dbh greater than 10cm. The larger the size of the trees, the better the forest condition.

Tree size in a forest is directly influenced by human activities such as cutting for fuel wood or for construction purposes. The enforcement of rules that regulate such activities is therefore important in determining the status of trees, and hence the condition of the forest. Data analyzed in this study were collected from a forest that exhibits two different management styles. One portion of the forest is managed as a national park, while the other portion is managed as a forest reserve. National park policy restricts any form of consumptive use such as cutting of trees, collection of fuel wood or livestock grazing. The forest reserve on the other hand permits limited amount of fuel wood collection, cattle grazing, and collection of deadwood. Management policy is thus expected to influence the size and distribution of trees and hence forest condition.

In addition to human factors, biophysical environmental factors also influence forest condition. Ecologists have demonstrated that elevation and slope steepness play a key role in determining tree size. Elevation is an indicator of climatic conditions. Beyond a given elevation, temperature and moisture regime may inhibit tree growth. A steep slope on the other hand exhibits more rapid movement of water and soil than a gentle slope, and the dangers of erosion and mass movement is greater. Tree establishment and survival on steep slopes is more difficult. Soil texture has been found to influence the water retention capacity of soils, and hence the type and size of trees that grow on a specific site.

We thus use OLS regression to investigate the following model:

Dbh= f(slope steepness + plot elevation + soil texture + rule enforcement + management)

Data were collected by the Kenya Forestry Research Institute (KFRI) from two forest sites, Kimothon forest block in Mt. Elgon Forest Reserve, and Chorlem in Mt. Elgon National Park in February and March of 1997. Data collection procedure followed the International Forest Resources and Institutions (IFRI) research protocol (http://www.indiana.edu/~ifri/research/ifrirestrat.html). 30 plots per forest were randomly sampled in each of the 2 forest sites. In each plot biophysical information was collected using nested concentric circles of 1-3-10 meter radii. Tree and sapling measurements of diameter at breast height (DBH) were taken in the 3 and 10 m plots. DBH is our dependent variable. It is an empirically determined measurement that represents tree size, and does not involve any hidden assumptions in its calculation. All other measures of forest structure such as basal area, biomass and tree volume are derived via standard formulae from DBH measurements. Socio-economic information was gathered using Participatory Rural Appraisal (PRA) techniques. Such information includes local community forest use, informal and formal rules for forest access and use, forest-related and non-forest related income and population size and distribution.

Results:

Following are the OLS regressions results:

$$(DBH)' = 134.9227 - 0.0500(PELEV) - 0.1501(PSTEEP) + 3.1265(RENFORCE)$$
$$\qquad\qquad (4.4840) \qquad (0.0022) \qquad\quad (0.1080) \qquad\quad (1.3886)$$

Prob>F=0.0001
R^2=0.7825, Adj-R^2=0.7808
N=383
DBH'= Predicted value of Diameter at breast height
PELEV= Plot elevation
PSTEEP=Plot steepness
RENFORCE= Rule enforcement: 1=rule enforced
0=rule not enforced

After examining the student residuals, we found that there were 8 outliers, which wedeleted. These trees were much larger than other trees. They are old trees that were identified as sacred by local communities and had been preserved for religious purposes. Although the local communities were removed from the forest when the forest reserve were created in the early 1930s, they still protect these trees. These outliers thus represent remnants of a population of trees different from that which we have analyzed.

The assumptions of normality, linearity, homogeneity of variance must be fulfilled for regression estimates to be valid, and for t and F statistics to be accurate.

Violation of univariate normality does not appear to be a serious problem for all continuous variables in our data set.

Linearity assumptions for the relationship between dbh and elevation appear to hold. However, the relationship between dbh and steepness does appear to have a semblance of linearity though it is not clear in which direction. The lack of a curved

pattern may be evidence that a non-linear form may be inappropriate to characterize this relationship.

Homogeneity of variance has been difficult to establish from all the residual plots, and caution should be taken in interpreting the regression estimates as they may be biased. Heteroscedasticity is known to bias the OLS estimators, and also to affect the accuracy of the t and F statistics. This may also point towards a lack of multivariate normality.

Perfect multicollinearity (r=1) was detected between soil texture, management and rule enforcement. These variables are dichotomous and since they varied in exactly the same way, it means that when all are plugged into the model at the same time, the effects of two of the variables are eliminated from the equation, as their participation is superfluous. To correct for this we eliminated the variables soil texture and management from the regression model.

Near multicollinearity was a problem we found between elevation and rule enforcement (r=-.8184). Although near multicollinearity does not bias the OLS estimators or affect the accuracy of t and F statistics, it tends to obscure the independent effects of highly correlated independent variables on the dependent variable. However, the results of our analysis indicate that in spite of multicollinearity between elevation and rule enforcement, the coefficients of these variables were significant, and the unique contribution of each could be detected.

Despite the uncertainty surrounding the homoscedasticity assumption, we find standard OLS regression to be an appropriate procedure for the analysis of relationships proposed here. By allowing many relevant variables to be included in the same model, it enables the assessment of the unique contribution of each variable to the variation in the dependent variable. It thus provides a good means for testing hypotheses that explore the importance of a wide range of variables on forest conditions. Multiple regression also enabled us to use dummy variables to quantify the effects of qualitative variables on forest condition.

Discussion and Conclusion:

Regression results indicate a strong (adj-R^2=78.08) and significant (p>F=0.0001) linear relationship between the dependent variable and the independent variables. About 78% of the variation in the dependent variable can be associated with variation in the independent variables.

Elevation and rule enforcement were significant, p>t=0.0001 and p>t=0.0249 for elevation and slope, respectively. Steepness does not have a significant relationship with dbh. This departs from theoretical expectations. A close inspection of the residual plots reveals that dbh appears to increase with slope steepness until about 6^0-8^0 after which dbh appears to decrease. This may have created a large standard error for the estimate, resulting in an insignificant result. The increase with dbh as slope steepness increases, and its decline at some point may be the result of two factors acting in concert. First, it may be that as slope steepness increases, the trees become less accessible to human exploitation. Hence there is a tendency to have larger trees on steeper slopes. However, beyond a certain steepness level, the physical factors of soil erosion and slope instability limit the size of tree that can be maintained under such conditions of instability. Due to thin soils caused by soil erosion, large trees are precluded from surviving here. Further,

conditions of slope instability, especially during heavy rains increase the risk of large trees falling.

Elevation, as expected, is significant and its sign positive. This is consistent with theory. Elevation is a rough indicator of climatic condition. As elevation increases, temperature gets cooler, and moisture less available. Conditions for tree growth are not favorable; hence we get smaller-sized trees with lower dbh values.

Standardized coefficients show that elevation is of greater importance in explaining forest condition than rule enforcement. This is a reasonable conclusion because cross validation of the data indicates that the regression equation is likely to be stable across different samples. Elevation is however a natural factor for which we do not have control. Rule enforcement is more within the realm of human control, and is the subject of interest in this analysis.

Rule enforcement is significant, as expected. This suggests that forest condition is better where rules are enforced than where rules are not enforced. Rules specify the terms and conditions of use of the forest and constrain destructive exploitation of the forest resources. It is important to point out that the study was conducted in a forest that is managed by two government agencies, the forest department for the forest reserve, and the wildlife service for the national park. As mentioned earlier national park policies are restrictive and do not permit consumptive forest use. Forest reserve policies are more flexible and permit a limited amount of use by local communities. By being allowed to use forest resources in the forest reserve, the community derives direct benefits from the forest, and thus has incentive to protect it, and use it wisely. To this end, the community has organized itself and crafted rules that regulate the use of the forest in order to assure future streams of benefits from the forest reserve. In addition, the community enforces the rules, and sanctions those who break rules. The outcome of this self-organization and rule enforcement is better forest condition in the forest reserve.

The national park pursues a less flexible management policy. Since communities are precluded from reaping direct benefits for the park forest, they see no use for organizing to protect it. Consequently, individuals exploit the forest as they see fit. As far as the individual is concerned there are no rules, and each will maximize extraction for as long as park officials don't catch them. If they're caught, they face prosecution. What makes the situation more challenging for park officials is that they do not have enough personnel to adequately patrol the park forest. Community enforcement would have greatly supplemented park officials' efforts at protecting the forest. Since community enforcement of rules is lacking, the park forest ends up in worse condition than in the forest reserve, where communities are actively involved in rule making and enforcement.

In the National park, a centrally designed and exclusive management has resulted in the forests being open access and degraded over time since local users have no rights to the resource. They do not have the freedom to devise rules limiting use to be involved in meaningful ways in reseource manageing the resources. The KWS is in charge and has been in charge for the past 37 years. Yet local populations regard the forest resource as rightfully theirs. This diregard for community rights and needs, and their resulting exclusion from decision-making process is a disincentive for local users to conserve the forest. They do not see the benefits of doing so. Indeed it is in their short-term interest to

exploit the forest as they wish. The outcomes of the disincentives facing these communities is a deteriorating forest in poor condition.

Local users in the Forest Reserve, on the other hand, have rights to use the resource. They make rules regarding how products shall be harvested and are involved in monitoring and enforcement activities. The communities in the Forest Reserve can ne viewed as “claimants”(Agrawal and Ostrom, 1999). Claimants possess operational rights of managing a resource. Such rights include the right to make decisions covering construction and maintencnace of facilities and the authority to devise limits on harvesting rights. The institutional flexibility of Forest Reserve management, by according claimant rights to local communities, create incentives that encourage communities to take long term benefits and short term costs into account when making decisions.

Clearly, a decentralized approach to forest management that devolves some bundle of property rights to local users results in beneficial, resource conserving outcomes. A centralized approach yields less positive outcomes.

References: