

**Welfare Implications of the Payment for Environmental Services:
Case of Uluguru Mountain –Morogoro**

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Abstract

This study was carried to find out the impact of PES (Payment for Environmental Services) on the welfare of the communities in the Uluguru Mountains. The aim of the study is to assess the main objectives of the PES project which is to conserve the environment (forest) and reduce poverty. The assessment of the project is done by looking on the difference between the treatment group (those who participate in PES) and control group (households who do not participate). The study employed a combination of questionnaire and field observation to collect primary data together with a detailed review of literature. The study utilized Propensity Score Matching (PSM), Descriptive statistics, Perception and Logistic analysis. In all the methods of analysis the results shows that there is a significant difference in the poverty status between treatment and control groups with treatment groups showing low level of poverty. In the regression analysis it is shown that participation into the programme, age of the respondents, the level of dependence on natural resources are found to significantly reduce poverty.

Keywords: Payment for Ecosystem Services, Welfare, communities Propensity Score Matching

JEL Classification: Q2, Q23, Q27

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1 Introduction

Monetary income is important as a means to satisfy a wide range of material needs, including food security, and increasingly also to satisfy other needs such as health services, education and safe drinking water and sanitation. In this sense income is a means to address a number of important dimensions of poverty although primarily that of material deprivation. In this perspective the improvement of income is essential for poverty alleviation. This justifies specific analytical efforts and reflection on the issue of rural incomes. The livelihoods of the rural poor can be improved within the framework of subsistence production or conservation of the natural resources and sustainable harvesting of the resources (Landell-Mills and Porras, 2002). However, there are early and decisive limitations on the potential for improvements within this production system. Significant, continuous and sustained improvements in people's income can only be achieved through a shift from a subsistence economy to a market economy. If the incomes of rural poor are to be improved significantly and continuously, yet another dimension of structural change is required. The opportunities for participation in product and service markets *outside agriculture* have to be expanded and made more remunerative.

One precondition for improved and sustained incomes for the rural poor is the preservation of the natural resource base on which so many depend, directly or indirectly. There must be incentives for users of the resources to care for long-term sustainability, and means to prevent others from exploiting or mining the resources. Secure tenure and self-interest can partly achieve this. The significance of secure tenure and capacity to enforce exclusion is particularly striking for common pool resources. For instance, forestland and water resources with open access tend to be seriously degraded, whereas secure tenure provided to communities or user groups have proven that sustainable management and use are feasible. Farmers are generally said to have self-interest in the sustainability of their natural resource base. However, under the pressure of poverty they may see no alternative but to sacrifice sustainability in order to satisfy their basic needs of today. One way in which this can be avoided is by raising productivity per unit of land and household incomes in general to reduce the need for overexploiting the resources. In addition, market incentives can be created for more sustainable and environmentally-friendly production through, for example, the promotion and growth of markets for eco-products or creating market for ecosystem services.

Understanding community's welfare implications as results of payment-for-environmental-services (PES) programmes is an essential precondition for any future designing effective and efficient programmes. Payments for ecosystem services are an innovative approach which allows integrated solution to natural resource management and is seen to provide necessary incentive to the adjacent communities especially in sustaining ongoing forest reforms in many of the developing countries (Robinson and Lokina, 2012). Many Payments for ecosystem services (PES) schemes were initially designed as means of financing natural resource management, with potential livelihood considerations added later. A major concern is that the poor will actually become worse off due to a PES scheme, for example as buyers of a service that was previously free (Landell-Mills and Porras, 2002). There is also the danger that the poorest and most marginalized will become further marginalized if they cannot participate effectively in the scheme, for example as buyers of a service that was previously free (see Wunder, 2005,

Robinson and Lokina 2011). Poverty reduction and environmental sustainability through community participation are not always complementary. If PES is not carefully designed and implemented there is a danger that part of the poverty reduction will be met by unsustainable exploitation of natural capital.

Previous studies have found that compensation for environmental services is not a cure-all for rural poverty and environmental degradation and that PES schemes can be valuable for diversifying livelihood strategies and improving natural resource management (See for example, Rosa et al, 2004). In order to reduce poverty PES schemes need to be part of wider strategies that expand and defend the whole basket of assets in the hands of the poor; otherwise, they could fail to benefit the poor, or even have adverse effects on them. Under the right conditions, PES schemes should focus on the poor rural communities and give them incentive for continued use of the resources sustainably. It has been established that PES is likely to reduce transaction costs (which have been found to be a major barrier to the participation of the poorest in PES activities, building on local community institutions and supporting new ones would strengthen social capital, thus increasing the resilience of the community and by supporting community infrastructure and services, it would establish longer lasting foundations for the improvements of local livelihoods than simply providing monetary income that in some cases is rapidly dissipated (See for example, Tacconi, et al (2009).

Past studies on the PES have shown that programme design and impacts may be improved by clarification of resource claims and environmental service provision rights, and simplifying programme goals to defensible biophysical and/or socio-economic criteria (Hope et. al.2005). For example a study by Theresia (2006) to determine the extent to which ecotourism has improved the livelihood of rural people and conservation of forest resources on Uluguru mountains, found out that majority of the people about 81.4% benefited directly and indirectly. Some benefits were household income, improvement of infrastructure and provision of social services. The major conclusion of the study is that ecotourism development in the study area has managed to improve local communities' livelihood by increasing their income and has contributed to the conservation of the forest thus reducing degradation of the forest

In Tanzania, this sort of approach exists in the Ruvu River upper catchments in the Uluguru Mountains. It was initiated by WWF and CARE in 2006 but its actual implementation started in 2008 and proceeded till 2012. WWF developed a new, holistic PES approach that explicitly aimed to balance poverty reduction with conservation. PES in Uluguru Mountains is seen as one of financing mechanism for conservation that, in the appropriate circumstances, will deliver both sustainable natural resource management and improved livelihood security for the communities adjacent to the forest. Equitable Payment for Watershed Services (EPWS) under WWF and CARE addresses this for the communities of Uluguru Mountains (especially Kibungo Juu ward) by improving the welfare of the people, that is, poverty reduction and environmental management.

The WWF seeks to promote the integration of environmental sustainability and social equity into economic development, the initiative within the program is focusing on how to scale-up current PES scheme so that they deliver substantial and long lasting conservation while

alleviating rural poverty by giving special attention to increasing the participation of the rural poor in PES schemes. The participation of communities in a payment for ecosystem services scheme is essential for success and sustainability. For a payment for ecosystem services transaction to be successful, it is necessary that rural community members actively participate from the beginning of project identification and design (Vonada et al., 2011).

The PES programme's effectiveness in Uluguru Mountains depends heavily on the voluntary participation of landowners in order for its objective of conservation as well as poverty reduction level of the communities to be achieved. The major aim of PES in Uluguru Mountains is to conserve the environment through which ecosystem services will be improved. While this objective has been addressed more widely, little has been done to capture the role of PES in addressing the poverty level among the community involved in the conservation. There has not been clear cut evidence that participation of the communities in the Uluguru forest under PES has helped to reduce poverty, and whether the improved ecosystem services has improved the welfare of the adjacent communities. The main objective of the study is to evaluate the impact of PES on poverty reduction for the participating communities adjacent to the forests. To accomplish this, the research attempted to address the following specific objectives: Examining the impact of PES on the welfare of the communities in Uluguru. Identifying significant differences in poverty level between people who participate in PES and those who do not participate in the program.

The contribution of forests to local livelihoods and the Tanzanian national economy as a whole is significant, but is largely unrecorded and consequently unrecognized. The difficulty of examining forestry in the context of economic growth arises because no markets exist for ecosystem services. Many transactions related to forest products and services fall within the informal sector or are undertaken illegally and are, hence, not recorded. Official gross domestic product (GDP) figures, on which the analysis of economic growth is made, do not reflect the "true" economic importance of the forest sector to the national economy (World Bank 2005). This "undervaluation" matters because the contribution to GDP and its growth determines decisions made by the government of Tanzania, and also to some degree its development partners, regarding the allocation of financial resources into the forestry sector.

One of the introduced aspects on forest management was Participatory Forest Management (PFM) concept which advocates Community-based Forest Management (CBFM) and Joint Forest Management (JFM) approaches. PFM reflects its varying degrees of involvement of local communities in the management of forest resources. The recent approach of PFM however, also appears to have some problems including lack of incentives for the participating communities (Malimbwi, 2002, Kiss, 2004; Robinson and Lokina 2011). It is proposed by neo-market natural resources economists that, new ways and institutional set-ups to supply for such required incentives have to be developed (Winrock International, 2004). This implies that for environmental services to be provided for by local actors, financial incentives have to be made available by international, national/regional and local actors. Thus, it is expected in the absence of any other incentive scheme, PES should be regarded as a necessary for the sustainability of the conservation measures. The PES and REDD+ schemes are expected to complement past forest reforms thereby contributing to generation of necessary incentives for forest management

by PFM projects. Under PFM, local communities that are managing natural forests by avoiding deforestation have to be compensated for their management efforts in order to reinforce their commitment to conserving natural forests and, in turn, safeguard their livelihoods.

The remainder of this study is organized in five sections as follows. Section two gives an overview of forestry in Uluguru Mountains, Morogoro, Tanzania. Section three spells out theoretical framework and methodology. Section four present and interprets empirical results. Section five concludes.

2 Overview of Forestry in Morogoro

Morogoro region has 47 Catchment Forest Reserves which are in four districts, Kilombero, Kilosa, Ulanga and Morogoro. Many of the reserves cover mountainous areas under a high rainfall and so are important catchments. The main mountain ranges are the: Uluguru and Nguru in Morogoro District; Udzungwa in Kilombero District; Mahenge in Mahenge District; and Ukaguru and Rubeho in Kilosa District. In Kilosa district there are 10 Catchment Forest Reserves which are; Ikwamba, Mamboto, Mamiwa-Kisara (North), South Mamiwa-Kisara, Uponera, Mamboya, Talagwe, Pala Mountain, Ukwiva and Kihiliri. Ulanga District Catchment Office Administers Eight Reserves, Which Are Mahenge Scarp, Nawenge, Mselezi, Myoe, Muhulu, Sali, Ligamba and Nambiga. Morogoro District Catchment Office administers 22 reserves. Fifteen of these are on or near the Uluguru Mountains, with the other seven on or near the Nguru Mountains. Kilombero District there seven catchment forest reserves, six of these reserves are on the eastern escarpment and foothills of the Udzungwa mountains, which are: Lyondo, Matundu, Iwonde, Nyanganje, Mwanihana and West Kilombero scarp reserve which is administered by Iringa region. On the southern part of the escarpment is Udzungwa scarp catchment forest.

2.1 Forest Sector in Uluguru Mountains

Formerly the Uluguru Nature Reserve (UNR) was managed by the Morogoro Regional Catchments Forest Project. It is classified as protected area whereby timber harvesting and other human activities are not allowed. The process to establish UNR started in 2004 with the support from the Conservation and Management of Eastern Arc Mountain Forests (CMEAMF) Project. The UNR is declared as the Nature Reserve in the Government Notice No. 296 of 7/11/2008. It covers 24,115.09 hectare and is comprised of the former Uluguru North Forest Reserve, Uluguru South Forest Reserve, Bunduki I and II Forest Reserves and Bunduki gap/corridor. It is owned by the Central Government through Forestry and Beekeeping Division of the Ministry of Natural Resources and Tourism (MNRT).

Uluguru Nature Reserve is surrounded by 57 villages with a total population of 91,426 (MPUNR 2008). The main ethnic group is Waluguru, who constitute approximately 80 % of the entire population. Other ethnic groups include Wapogoro, Wandamba, Wahehe, Wanyakyusa, Wabena, Wazigua, Wasukuma, and Wakaguru. Reasons for moving from one village to other include searching for agricultural land, searching for employment, due to marriage and transfers. Thus population differs from one village to another. Statistics on population shows that some

villages such as Mgeta and Bunduki are highly populated. For example, population density on the slopes of the Uluguru is over 159 persons per square kilometer (URT 2012).

The UNR is an Eastern Arc type of forest with species of restricted distributions and endemism. With the exception of rock outcrops, the UNR consists sub montane (below 1500m a.s.l), montane (above 1600-2400m a.s.l) and upper montane (above 2400m a.s.l) forests. Also there are interesting features such as the upland grassland with swampy areas called *Lukwangule* plateau, *Kimhandu* and *Lupanga* peaks. These features attract local and foreign tourists. However, some areas of the UNR are inaccessible due to steep rocky outcrops. UNR is a source of many rivers namely, Ruvu, Mgeta, Morogoro, Tangeni, Mfizigo, Mmanga, Mzinga, Ngerengere, Mvuha, Mbezi, Mngazi, Bigwa, Kilakala, Bamba and Kikundi Rivers. All rivers provide water to the local communities and beyond. For example, Ruvu River supplies water to the capital city Dar es Salaam, Coast and Morogoro Regions used for both domestic and industrial purposes. Despite all these major benefits of the UNR, the Mountain and the ecosystems are facing major threats mainly from human activities such as farming, charcoal burning and settlement. The other major threats to the Uluguru Mountains is the presence of invasive species (*Rubus* in the south and *Maesopsis* in the north).

Through various project interventions, residents of Uluguru have planted different tree species for purposes of meeting different needs related to forests. The main forest products used by the local communities include timber, poles, withies, and ropes, fuel wood, charcoal and medicinal plants. Others include honey, wild fruits, thatch grass, wild birds, bush meat, wild vegetables, insects, mushrooms and roots/tubers. These products are utilized at different level of intensity.

Local Communities like Lanzi, Kibungo, Dimilo and Nyingwa which live adjacent to the Uluguru forest are the major beneficiaries from a well managed Uluguru forests: directly through collection of non-timber forest products, and indirectly from improved moisture levels. The benefits of a well protected Uluguru forest extends beyond the adjacent communities through the provision of water to distant cities; and in contributing to global biodiversity. However, previous studies have shown that many adjacent villagers feel worse off as a result of the introduction of PFM because of their reduced access to forest (See for Kajembe et al , 2006; Robison and Lokina, 2011; Lokina and Banga 2010, Lokina, 2012). In order to improve livelihoods and reduce conflict and making the protection of the forest more sustainable and more equitable, Payment for environmental services (PES) as part of a conservation paradigm that explicitly recognizes the need to bridge the interests of landowners and outside beneficiaries through compensation payments.

The principle behind the method is that the beneficiaries of the environmental services pay for the services that they receive to the land users who generate those services. In turn land users manage forest, reforest or implement other conservation-friendly resource management schemes that will ensure the sustainability of the environmental services that the beneficiaries receive.

PES schemes include carbon sink functions, watershed protection, and biodiversity. PES compensates communities adjacent to the Uluguru forest to change current land use practices by planting trees and conservation farming so as to reduce forest products harvesting and reducing

soil erosion so as to protect the flow and depth of water in the Mfizigo sub catchments which makes the Ruvu River. A total of 420 acreage in the Kibungo sub catchments is involved in the conservation activities which is 33% of the targeted land. As shown in Table 1, Nyingwa village is the largest of all in terms of the number of households as well as population wise. In this village about 50% (approximately 700 acreage) of total land area is targeted for conservation under the PES scheme. Communities are expected to benefits from this scheme through increased productivity as a results of improved farming techniques for example terracing (CARE, 2007). Therefore it is important to identify ways of securing benefit streams to household/individual so as to facilitate conservation of the forest and improve their livelihoods.

Table 1: Demography of the villages involved in the implementation of PES in conserving the Uluguru forest

Village name	Household	Males	Females	Total
kibungo	316	593	697	1290
Dimilo	234	511	542	1053
Lanzi	303	613	617	1284
Nyingwa	319	695	797	1492
Total	1586	2904	3393	6297

Source; ward office; All of the villages are in the Kibungojuu ward of Morogoro Rural District

3 Theoretical framework and Methodology

Poverty is a complex concept. It entails a complex interconnection of descriptors surrounding the livelihood status of people in communities. According to the World Summit for Social Development held in Copenhagen in 1995 “Poverty has various manifestations including lack of income and productive resources sufficient to ensure sustainable livelihoods; hunger and malnutrition; ill health; limited or lack of access to education and other basic services; increased morbidity and mortality from illness; homelessness and inadequate housing; unsafe environments; and social discrimination and exclusion. It is also characterized by lack of participation in decision making and in civil, social and cultural life”

Tanzania signed up to the Millennium Development Goals (MDGs). The First MDG commits Tanzania to reduce poverty between 1990 and 2015 by 50%. The incidence of poverty in Mainland Tanzania declined marginally from 35.7 per cent in 2001 to 33.6 per cent in 2007, further declining to 28.2 in 2011/2012 (URT, 2009b; URT, 2014b¹²). Table 2 shows the proportion of people living below the basic needs poverty line as revealed by Household Budget Survey (HBS) for years 1991/92, 2000/01, 2007 and 2011/12. Over a twenty year period, poverty declined only by about 10.5 per cent.

¹² A different approach has been used to estimate the poverty rate for 2012, and therefore the results may not be comparable to those of previous Household Budget Surveys.

Table 2: Incidence of Poverty in Tanzania

Year	Dar es Salaam	Other Urban Areas	Rural Areas	Mainland Tanzania
1991/92	28.1	28.7	40.8	38.6
2000/01	17.6	25.8	38.7	35.7
2006/07	16.2	24.1	37.4	33.3
2011/12	4.1	21.7	33.3	28.2

Source: Household Budget Survey Reports (Various issues)

Poverty rates have been consistently higher in rural areas than in urban areas. The rural poverty incidence is compounded by low rural growth as measured by the growth of the agricultural sector, which has been stagnant over the years, declining in some years, for example from 4.2 per cent in 2010 to about 3.6 per cent in 2011 (URT, 2012c). Rural poverty is worsened by the lower real growth in rural per capita incomes, thereby perpetuating the cycle of poverty in the rural areas.

To capture the effect of PES in poverty alleviation the study compares two groups those participating in the program and those not participating using the propensity score (PS) technique, introduced in the 1980's (Rosenbaum and Rubin, 1983) and has its roots in a conceptual framework which dates back even further (Rubin, 1974). Its simplistic approach to estimating the programme effect would be to compare the outcome of programme participants with those of non-participants. This would be a valid approach where those participating in the programme is a random sample of all those eligible.

PSM use quasi experimental methods which selects project beneficiaries and non-beneficiaries who are as similar as possible in terms of observable characteristics expected to affect project participation as well as outcomes. The difference in outcomes between the two matched groups can be interpreted as the impact of the project on the beneficiaries (Smith and Todd, 2001). The key assumption made in PSM is that selection into a programme can be captured with observable data that are available to the evaluator. This is known as the Conditional Independence Assumption (CIA) (Heckman and Hotz 1989). For this identifying assumption to be plausible, one must be able to control for all characteristics affecting both participation and the outcome of interest. In our case we are looking at the effect of participation in PES in conserving the forest if it has helped to reduce poverty. The propensity score methods are increasingly being used in observational studies in which, baseline characteristics differ between the exposed and unexposed groups; exposure is relatively common; the number of measured characteristics or potential confounders is relatively large; and the number of events is relatively small (Trojano, 2007). The PSM has an advantage over regression analysis as it does not make assumption on the functional form. (Dehejia and Wahba, 1998). It is further able to capture all of the variance in the covariates relevant for adjusting between-group comparisons (Rosenbaum and Rubin 1983) and hence one can estimate the Average impact of treatment on the treated (ATT) to beneficiaries and non-beneficiaries with comparable propensity scores.

In doing matching, different approaches are used to match participants and nonparticipant on the basis of PS, which include nearest-neighbor (NN) matching, caliper and radius matching, stratification and interval matching and kernel matching and local linear matching (LLM). PSM is useful only when observed characteristics are believed to affect program participation. Thus the main advantage of PSM relies on the degree to which observed characteristics drive program participation. It also doesn't necessarily require a baseline or panel survey although in the resulting cross section, the observed covariates entering the logit model for the PS would have to satisfy the conditional independence assumption by reflecting observed characteristics X that are not affected by participation. It imposes few constraints on the treatment model and few assumptions about the distribution of the error term.

3.1 Sampling strategy and Data

A purposely sampling of the villages of Morogoro Rural district was done to households adjacent to the Uluguru Mountains and those which are involved in the PES project. A total of 57 villages are found in the Uluguru Mountains some being involved in the program. Household were randomly sampled from KibungoJuu Ward in four selected villages of Lanzi, Nyingwa, Dimilo and Kibungo to ensure adequate representation of the villages. Selection of household for the study was done to ensure representativeness i.e. having mixed kind of respondents in terms of age composition, gender, economic status, harvesting and use of resources, economic activities etc. In each selected household, a head of household or elder member of the household was interviewed using a structured questionnaire. The questionnaire aimed at collecting, among others, data on household size and composition; length of residence in Uluguru and place of origin, Education level of household head, Equipment owned by the household (tools, transport, etc.), level of cash income, Livestock ownership, Land area (total, and farmed); main livelihood activities (e.g. farming, livestock, business, employment, remittances), and their perceived relative importance to the household, income from involvement in PES project. For each of main livelihood activities, annual production, proportion sold and home consumed; relative importance of different livelihood sources (including forest product) over the year, cost of wild animal damage to crops (if any), livestock, etc.

The focus group discussions was held to collect information of a generally applicable nature, e.g. on seasonality, markets and prices. Other information collected includes agricultural practices and the corresponding prices. The study also collected community/village level data. The aim of collecting village level data was to get general data at high level which form the basis for validation of information from individual respondents. The village data collected include main economic activities, population data, available facilities such health, schools, extension services, environmental management practices, general welfare of communities etc.

The study covers 200 respondents, of which 100 (or 50%) comprise of the treatment group and 100 (or 50%) of the comparison group. Poverty status of these two groups was examined to find out if there is any difference on welfare status between the supported and not supported groups. Table 3 shows the composition of the sampled villages and group members (participants and

Non participants) from Kibungo, Lanzi, Dimilo and Nyingwa (study areas) in Morogoro rural district

3.2 Propensity Score Matching

In an attempt to obtain an estimate of the impact of PES, in comparing the outcome of the treated individuals with that of a similar control group we make use of Propensity Score Matching (PSM) which is used since observed characteristics are believed to affect program participation. Since it's a single treatment then Logit model will be more appropriate to calculate Propensity Score (PS). Let P_i represent the probability of a person participating in the program and $1 - P_i$ is the probability of the person not participating. And we have the outcome **1** if the person participates and **0** if he does not, then we have the following.

$$\Pr(Y_i = 1) = P_i \tag{1}$$

$$\Pr(Y_i = 0) = 1 - P_i \tag{2}$$

The probability of a person to participate is given as

$$P_i = E\left(Y = \frac{1}{X}\right) = \frac{e^{\beta_0 + \beta'X}}{1 + e^{\beta_0 + \beta'X}} \dots \tag{3}$$

$$P_i = E(Y = 1 | X) = \frac{e^{(\beta_0 + \beta'X)}}{1 + e^{(\beta_0 + \beta'X)}} \tag{4}$$

Where, X is a vector of independent variables and β is a vector of their respective coefficients. For ease of expression and understanding, equation 4 is thus simplified as

$$P_i = E(Y = 1 | X) = \frac{e^{(\beta_0 + \beta'X)}}{1 + e^{(\beta_0 + \beta'X)}} = \Lambda(\mathbf{x}, \beta) \tag{5}$$

Notation $\Lambda(\mathbf{x}, \beta)$ indicate the logistic cumulative distribution function. The probability therefore of a person not to participate can thus be given as

$$(1 - P_i) = E(Y = 0 | X) = \frac{1}{1 + e^{(\beta_0 + \beta'X)}} = \Lambda(\mathbf{x}, \beta) \tag{6}$$

From equation (6) P_i ranges from 0 to 1 and is non-linearly related not only to the regressors but also to the parameters thereby causing some estimation problems in as far as ordinary least squares (OLS) estimation technique is concerned. Thus a non-linear model will need to be estimated, and we can reformulate these equations in terms of the odds ratio of the probability of the person to participate to the probability of the person not participate. And this equation will be as follows:

$$\left(\frac{P_i}{1 - P_i} \right) = e^{(\beta_0 + \beta' X)} \quad (7)$$

Taking the natural logarithms of the equation we get the Logit model and which can then be observed that the log of the odds ratio is not only linear in X , but also in the parameters β ;

$$\ln \left(\frac{P_i}{1 - P_i} \right) = L_i = \beta_0 + \beta' X \quad (8)$$

The interpretation of Logit as odds-ratio is an attractive feature of Logit model. Since Logit gives log of the odds and that is the reason for the Logit estimates sometimes to be referred as log-odds estimates. Therefore odds ratio can be calculated simply by exponentiation the Logit estimates. Interpretation of odds ratio depends on whether the coefficients are greater, less or equal to 1. Expressed in this way, it is a little easier to see what is going on with the odds ratio.

When the probability of a 1 (“*success*”) is less than the probability of a 0 (“*failure*”), then the odds ratio will be less than 1. When the probability of a one is greater than the probability of a 0, the odds ratio will be greater than 1. When the odds ratio is exactly 1, this says the odds of success and failure is even. Therefore when interpreting an odds ratio, if the value is greater than 1 then any change in variable will favor success and when the coefficient is less than 1 then any change in variable will favor failure. Also in interpreting odds ratio it is often helpful to look at how much it deviate from 1.

Any standard probability model can be used to estimate the propensity score. On the other hand, a variable should only be excluded from analysis if there is consensus that the variable is either unrelated to the outcome or not a proper covariate. If there are doubts about these two points, Rubin and Thomas (1996) recommend to include the relevant variables in the propensity score estimation. When using all the available covariates, bias arises from selecting a wide bandwidth in response to the weakness of the common support, using a lower number of covariates, common support is not a problem but the plausibility of the confoundedness assumption is. Moreover, this trade-of also affects the estimated standard errors, which are smaller for the minimal specification where the common support condition poses no problem. Finally, checking the matching quality can also help to determine the propensity score specification.

After the **PS** equation is estimated the predicted values of participating from participation equation are obtained. The region of common support is defined where distributions of PS for treatment and comparison group overlap. We use the kernel and local linear matching for matching the participants and non participants since with the other methods only a small subset of nonparticipants will ultimately satisfy the criteria to fall within the common support and thus construct the counterfactual outcome. With kernel and Local Linear Matching (LLM) use a weighted average of all nonparticipants to construct the counterfactual match for each participant. If P_i is the **PS** score for participant i and P_j is **PS** of nonparticipant j , the weights for Kernel matching are given by;

$$\omega(i, j)_{KM} = \frac{K\left(\frac{P_j - P_i}{a_n}\right)}{\sum_{k \in C} K\left(\frac{P_k - P_i}{a_n}\right)}$$

$K(\cdot)$ is a kernel function and a_n is a bandwidth parameter. Kernel matching is analogous to regression on a constant term whereas LLM uses a constant and slope term, so it is linear. LLM can include a faster rate of convergence near boundary points (Fan 1992, 1993). The nearest neighbor matching is used to be precise with Kernel, **NN** match treated and control units taking each treated unit and searching for the control unit with the closest propensity score; i.e. the Nearest Neighbor. Although it is not necessary, the method is usually applied with replacement, in the sense that a control unit can be a best match for more than one treated unit.

The formula for the **NN** matching estimator is:

$$ATT^{NN} = \frac{1}{N_T \sum_{i=1}^{N_T} [Y_i^{obs} - \sum_{j \in C(i)} W_{ij} Y_j^{obs}]}$$

N_T is the number of observations in the treated group

N_i^C is the number of controls matched with treated observation i

W_{ij} is equal to $\frac{1}{N_i^C}$ if j is a control units of i , and zero otherwise

By using the asset index, the socioeconomic status of the households was categorized into two groups, that is poor and non-poor and the two categories were given the value of **0** and **1** consecutively. This categorization is basing on the NBS 2012 rural poverty incidence which was 33.3%. Furthermore the project impact was analyzed by looking on the economic difference between the participants and non-participants groups. From there the significance of the socioeconomic status was tested with ANOVA analysis. This was done to find out if the difference was the results of the project or was to be there even without the establishment of the PES project.

4 Results and Interpretation

4.1 Descriptive Analysis

In this section data are described to see their behavior before undertaking PS analysis. This will help to understand the nature of the sample data collected. Data was collected from four villages in Kibungo Juu ward found in Morogoro rural district for participants and non-participants in PES activities. A total sample size of 200 households, 50 from each of the four villages, was randomly selected. A head of household or a single person involved in decision making of the household was interviewed. From the sample data collected 44% and 55% of the respondents are females and males respectively. The mean age of respondents was 39 years old and the majority of these could read and write, as about 76% completed at least primary education. The average household size in Kibungo Juu ward is 5.2, which is relatively less than the national average of 6 household members (HBS 2007). Table 3 provides the summary of the population of the surveyed village and the sampling.

Table 3 Overview of surveyed villages

Village	Population	No of HHs	Surveyed HHs	Share interviewed
Nyingwa	1492	319	50	15%
Dimilo	1053	234	50	21%
Lanzi	1284	303	50	16%
kibungo	1290	316	50	15%

Source: Ward office

The sample was randomly selected and all the respondents surveyed were aware of PES but not everyone participated due to factors like sickness, some decided not getting involved, some were busy with family activities, some had family problems that prevented them from participating. It was also observed that some didn't understand the benefits of the PES. From the sample it was found that about 42% participated immediately when the program started; 8% joined later and 50% didn't not participate at all (non-participants). It is hypothesized that the factors that mainly determined participating in the program are ownership of land, the respondent's age, the education level, their gender, the household size and the consumption expenditure. It is important to note that the participation into the program is voluntary. Table 4 gives the mean value of the variables used in the regression analysis.

Table 4 Summary of descriptive Statistics of the variables used in the analysis

Variable	Description	Mean	Std. dev	Min	max
Age	Actual age of respondent in years	39.83	13.78	17	83
Education	Education level of the respondent; 1=professional and above, 0 otherwise	0.89	0.31	0	1
Household Size	Number of households	5.26	3.09	1	21
Gender	1=Male; 0=Female	0.55	0.49	0	1
Cons. Expenditure	Household consumption expenditure in Tshs	6985	2622.78	2000	14000
Land	Size of Agriculture land owned by the respondent in acres	2.87	3.69	0.5	40
Marital Status	Marital status of the respondent; 1=married, 0 otherwise	.55	.49	0	1
Assets Owned	Number of assets owned by the household	12.94	1.355	9.8	18.93
Years Lived in the Village	Number of years lived in the village by the household	30.115	17.03	1	83
Food Security	measured by number of meals per day	2.29	0.63	1	4
Welfare	perception of household after 2008	2.21	0.89	1	3
Participation into PES	Households participation in PES activities; 1=Yes, 0=No	0.5	0.50	0	1
Forest Product	Households commonly harvested forest products; 1= food products, 0=non-food products	0.22	0.41	0	1
Change in Plot Ownership Size	Amount of plot that has increased due to PES	0.89	0.313	0	1
Number of Years Owned the Plot	Number years the household owned the plot	16.3	15.86	1	82
Type of Land Tenure (Titled)	Households legal title or ownership rights for the plot of land	4.22	1.20	1	5

Social Economics and Livelihood Data

Based on the survey, the socio-economic characteristics of the households in Kibungo Juu community were analyzed specifically on the villages supported by the PES project to assess the impact of the projects on sustainable livelihood. Main characteristics of interest are those related with livelihood assets possessed by household members and therefore are for the household as whole. Three types of livelihoods assets are distinguished, these are physical, human and social assets and are included in the analysis.

Standard of Living Before and After Year 2008

Respondents were also interviewed on how they compare their household welfare after year 2008. The main intention for this was to look at how they perceive their standard of living after the establishment of the PES project. As noted earlier that the project started in 2008. Participants viewed to be better than they were before while majority of the nonparticipants said things are the same or had improved a bit. More than 67% of the participating group said their lives had improved compared to how it was before due to the increase in harvest of crops, which increased the income and food. This was due to the improved farming techniques that they were taught like contour or terrace cultivation and the use of manure. But on the contrary, only 29% respondents from the non-participating group agreed that the living standard is a little better now. Figure 1 summarizes the details.

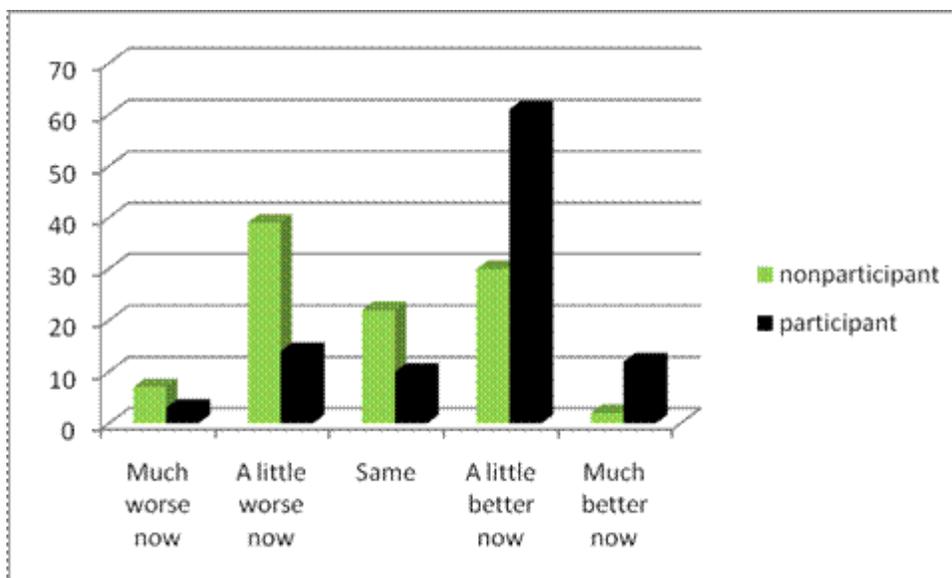


Figure 10: Perception on the standard of living before and after the PES

Looking further into the data we found that those who are likely to join the PES are those who are on average richer compared to the poorest family members. Supporting the earlier literature which pointed that if PES is not handled careful it can deepen the poverty level as the poor are likely to be excluded (see for example Landell-Mills and Porras, 2002). The data are analysed using the amount of money each household spend on food items. The two groups of participants and non-participants are grouped into five quintiles of poorest, the poor, average, the rich and the richest. Using this categorization the share by the quintile group between PES and non-PES participants is analysed. The results shows that the poor and the poorest quintile has the relatively larger share of non-participation in the PES scheme, whereas those with the largest share of income have also the largest share in participation and in the non-participation of the PES activities.

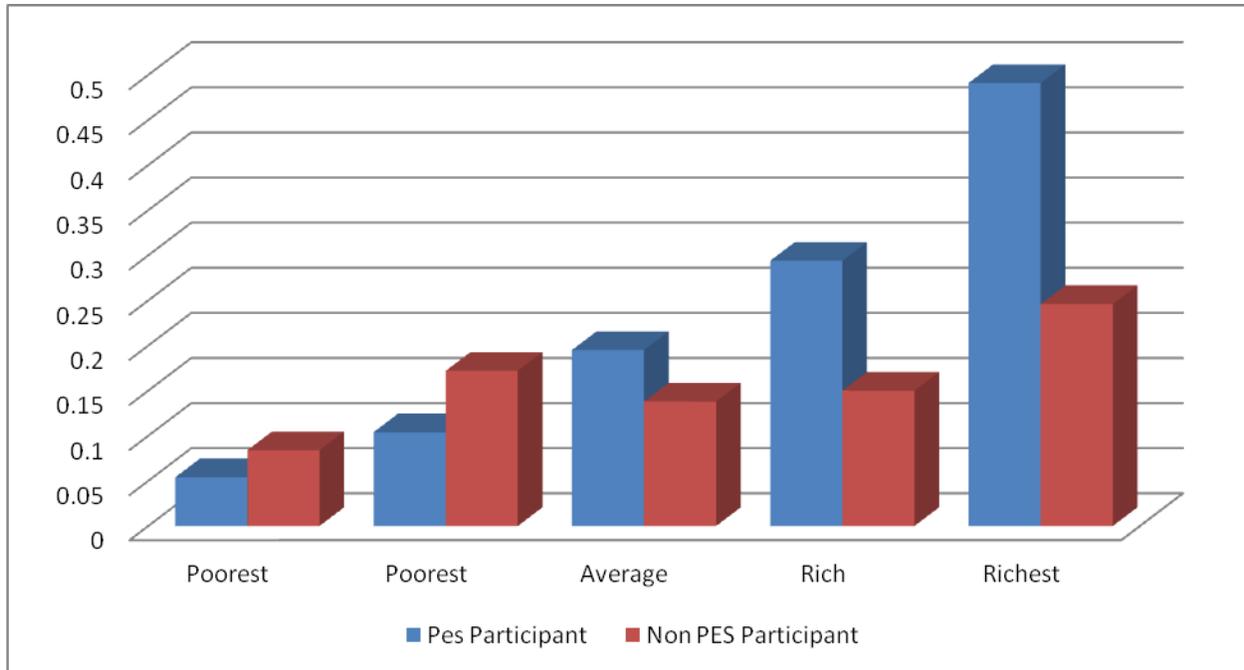


Figure 11: Share of participation and Non participation in PES

Comparison of the Household’s Standard of Living with Others in the Community

Furthermore, each household was also required to compare his or her living standard with other households in the community. In response to this question, the results points out that, respondents from the supported group perceive their standard of living as somehow good compared to other non-participating households in community (See the details in Figure 3).

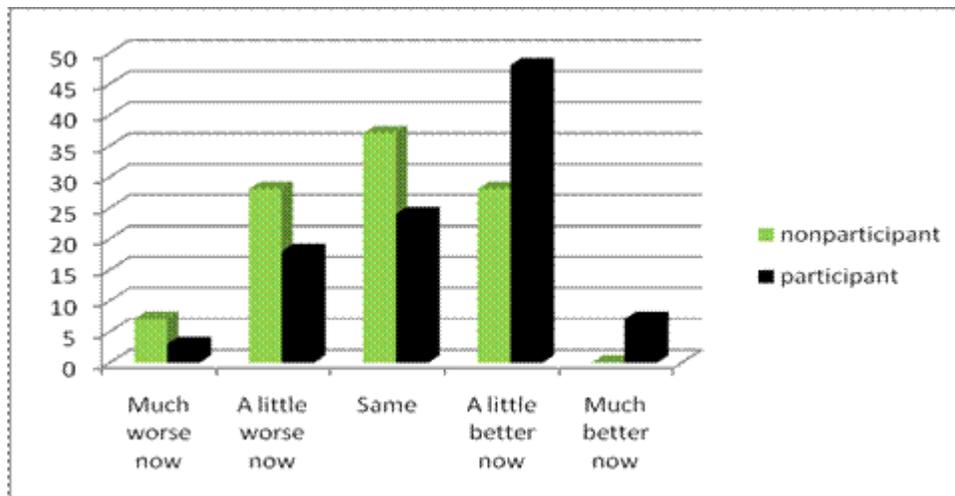


Figure 12: Households Perceptions on their standard of leaving

4.2 Construction of Wealth Index (WI) and Comparison of Poverty/Welfare between Participants and Non-Participants

The wealth index categorises (asset index) households into two groups as poor and non-poor. The constructed index takes two values which is 0 for poor and 1 for non-poor. As presented in Table 5 categorization is based on the NBS (2001 and 2007) rural poverty incidence of Tanzania and field survey where by 38.5% of the Kibungo-Juu households are considered as poor and 61.5% to be non-poor. Based on this asset index it has been found that, households who are nonparticipants of PES have large proportions of households into poor category than that from the supported. The results show that out of poor households in the study area 55% of poor household comes from the non-participants while the participants group takes only 45%.

The analysis went further by looking on if this difference in welfare between the two groups was a result of PES project in the community. This was achieved by using ANOVA analysis where by the results were found to be significant at 5% level . This is significant enough to prove that the project has impact on welfare difference between the households who are participating in the project and those ones who do not participate. This is a significant finding in this study as is contrary to the earlier findings by Mkenda, (2007, 2009), where he could not find the significant difference between the sample of under RUMAKI and those outside the RUMAKI programme. It is however, consistence with the findings by Gervas (2010), where it was shown that there were significant improvements of welfare of communities participating in MACEMP compared to non-participating communities.

Table 5:ANOVA Results for Project Impact

	Sum of squares	df	Mean square	F	Sig
Between groups(combined)	0.428	1	0.42	1.707	0.019
Within groups	49.57	198	0.25		
Total	50	199			

4.3 Propensity score matching results

The propensity scores were computed using binary Probit regression models. We estimated logistic model for comparing PES beneficiaries with all non-beneficiaries, the dependent variable in the model is a binary variable indicating whether the household was a beneficiary of the PES project. The explanatory variables used in computing the propensity scores are those expected to jointly determine the probability to participate in the project and the outcome. The focus was on the determinants of participation and productive assets when selecting the independent variables for computing the principle score matching.

Table 6: Logistic Regressions Estimates for Participation in PES

Participation	Coefficient	Robust Std. Err	Z	P> Z
Gender	-0.230	0.198	-1.16	0.246
Age	0.013	0.008	1.53	0.127
Education	0.297	0.329	0.90	0.366
Household size	0.087**	0.035	2.50	0.012
Land assets Owned	0.037 0.249**	0.058 0.109	0.64 2.28	0.525 0.023
Consumption Expenditure	0.396***	0.154	2.57	0.010
Marital Status	-0.303	0.225	-1.34	0.180
Years lived in the village	0.004	0.006	0.60	0.547
Constant -	-7.974	1.891	-4.22	0.000
Sample size	200			
Prob > χ^2	0.0000			
Pseudo R2	0.157			
Log likelihood	-116.76618			

The study found that PES participants are more likely to have large households with a 0.087 treatment effect. Comparing with nonparticipants, participants also tend to be older and have more land. Ownership of assets was one of the factors also mentioned by the respondents that influenced participation and from our model we see a 0.249 treatment effect. Example an interview with some of the households who did not participate one of their reason of not getting involved was lack of land to cultivate and farming tools like hoes (*jembe*) and bush knife (*panga*)

Consumption expenditure of the respondents is marginally significant in influencing the participation into the program suggesting that the PES might have been more attractive to the people in earning more for their consumption, from our model there is 0.396 treatment effect. The model results were used to compute the propensity scores that were used in the Propensity Score Matching (PSM) estimation of Average Treatment effect for the Treated. Further testing of the comparability of the selected groups was done using a “balancing test” (Dehejia and Wahba, 2002), which tests for statistically significant differences in the means of the explanatory variables used in the model between the matched groups of PES participants and nonparticipants. In all cases, that test showed statistically insignificant differences in observable

characteristics between the matched groups, supporting the contention that the PSM ensures the comparability of the comparison groups.

The region of common support is [0.097, 0.998] where only 198 observations are matched with control observations with a mean of 0.503 and Std. Dev 0.215 with 4 blocks. The number of blocks ensures that the mean propensity score is not different for treated and controls in each block and the balancing property is satisfied. The final distribution of treated and controls across blocks are tabulated together with the inferior of each block. (See Table 7)

Table 7: Inferior bound, the number of treated and controls for each block

Inferior of block of Pscore	Do u participate in PES activities		Total
	No	Yes	
0.0971367	23	4	27
0.25	47	33	80
0.5	23	37	60
0.75	5	26	31
Total	98	100	198

Table 7 shows that only 98 of non participants matched with 100 participants in the common support of the sample of 200. Several methods are possible for selecting matching observations (Smith and Todd, 2001). We used the kernel matching method (using the normal density kernel), which uses a weighted average of “neighbors” (within a given range in terms of the propensity score) of a particular observation to compute matching observations. Unlike the nearest-neighbor method, using a weighted average improves the efficiency of the estimator (Smith and Todd, 2001). Observations outside the common range of propensity scores for both groups (i.e., lacking “common support”) were dropped from the analysis. This requirement of common support eliminated about some of the total number of observations, indicating that few of the observations from the various strata were not comparable.

The results are consistent, showing that participation increases the outcome variable by 30 percent, at a 5 percent significance level. 89 households out of the 100 of the control group (non-participants) are matched with 100 of the treated group (participants). Only a few households from the control group are left in matching showing a significant effect of the PES program in effecting the program outcome.

Welfare

The study also adopted multinomial probit to estimate the perception of household on there welfare before and after 2008. Table 8 summarizes the main results. The study found that the probability of a household perceiving welfare improvement increases with assets availability and household size but decreases with the age of the household. If a household owns assets, it is likely to perceive that the welfare has been improved by 0.293 units. Furthermore the household size is likely to be perceived to make welfare better by 0.045 while it decreases the probability of the household perceiving that their welfare has been worse by 0.049. The results further show that the age of household head is likely to determine how they perceive their welfare, For

example an increase in the age reduces the probability of belonging to the group that perceive their welfare as being better by 0.011 units, since with old age the ability to obtain forest products is reduced due to the distance to obtain and hence make use of the trees planted due to PES project.

Table 8: Results of Marginal effects after MNP for welfare

Variable	outcome 1(worse)		outcome 2(same)		outcome 3(better)	
	dy/dx	P>z	dy/dx	P>z	dy/dx	P>z
Gender	0.022	0.765	0.021	0.698	-0.043	0.594
Age	0.010***	0.002	0.0007	0.783	-0.011***	0.004
Marital Status	0.057	0.476	-0.0187	0.757	-0.038	0.664
Education	0.153	0.118	-0.085	0.421	-0.068	0.609
Household Size	-0.049***	0.008	0.0041	0.73	0.045**	0.014
Log of Consumption Expenditure	0.017	0.747	.00068	0.986	-0.017	0.765
Log of Assets Owned	-0.169	0.129	-0.1247	0.226	0.293**	0.019
Log of Land	0.123	0.247	0.105	0.285	-0.229*	0.053
Biodiversity After PES	0.038	0.71	0.101*	0.099	-0.139	0.222
Forest Size After PES	0.039	0.677	-0.077	0.316	0.037	0.734
Years lived in The Village	-0.001	0.679	-0.0006	0.756	0.001	0.57
Participation	-0.308***	0.000	-0.111**	0.048	0.420***	0.000
Forest Products	0.108	0.266	-0.122**	0.027	0.013	0.895

* Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Moreover the probability of a household perceiving that their welfare is better increases with household participation in PES program by 0.420 units but household participation reduces probability of welfare being perceived worse or being the same by the household by 0.308 and 0.111 units respectively. The results further show that if the household own land it is likely to perceive that their welfare is better but with an increase in the ownership of land reduces the probability of perceiving a better welfare due to PES by 0.229 units since land ownership could have been a result of clearing more forest land so as to acquire land for agriculture.

An increase in Biodiversity availability after PES introduction is likely to increase the probability of household perceive welfare being the same by a 0.101 units but its not the case with availability of forest products as an increase in forest products reduces the probability of households perceiving welfare being the same by 0.122 units. It is surprising to notice that majority of the variables that characterize the household's welfare are not significant under "same" or "better". Consumption expenditure for their daily livelihood could be the earliest signal on whether their welfare has become better or is still the same. Variable like education level which is likely to explain their perception on welfare was found insignificant. The education level is likely to influence the perception on welfare improvement as a result of the

PES since more educated people are likely to perceive welfare gain from PES as compared to uneducated people. The insignificant of education variable could be due to the lack of significant variation in education level among the households. Majority of the households have primary level education.

Table 9 presents marginal effects of the Probit model estimates of the determinants of the change in forest size which gives the situation on the quality of the forest following the introduction of PES. The marginal effects show that one unit increase in the independent variable increases/decreases the probability of the dependent variable by the magnitude of the change. Gender is positive and statistically significant at 5% this suggests that male are likely to perceive positively that forest size has improved due to PES programme by 0.147. Furthermore, one year increase in the time lived in the village by household increases the probability on their perception of forest size change from PES activities by 0.0075 which is statistically significant at a 1%.

The increase in Forest size as a result of PES activities reduces the probability of perceiving the forest has been destructed. Among the strategies of PES is to encourage villages to plant tree in their own farm, which they can make use for their fuel wood and other NTFP needs at the household level. This is also the case on the perception of Biodiversity availability in the forest after PES activities which reduce the probability by 0.2 units of perceiving further loose of biodiversity.

Moreover an increase in forest products increases the probability of perceiving an improvement in the forest cover by 0.182 units since with PES people are able to obtain forest products from the trees that they planted in their own farm. An increase in the asset ownership reduces the probability on the perception of the improved forest cover by 0.137 units.

Table 9: Marginal Effects of Probit Regression Results on perception of the forest size

Variable	dy/dx	Std. Err.	z
Gender	0.147**	0.074	1.97
Age	-0.004	0.003	-1.5
Education	-0.031	0.11	-0.27
Marital Status	0.0349	0.083	0.42
Household Size	0.0242	0.017	1.37
Years lived in the Village	0.0075***	0.0026	2.83
Log of Assets	-0.137*	0.078	-1.76
Log of Consumption Expenditure	-0.054	0.052	-1.04
Log of Land	0.1116	0.073	1.52
Forest Size After PES	-0.306***	0.074	-4.1
Biodiversity After PES	-0.200**	0.089	-2.22
Forest Products	0.1826**	0.072	2.51
Participation	0.0575	0.076	0.75

* Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

5 Conclusions

The study aimed at evaluating the impact of PES on poverty reduction and the welfare implication of the adjacent communities. The analysis is based on participants and non-participants in to the programme. Four villages from Uluguru that are in the program were chosen for this study. The sustainable livelihood in this study is defined in relation to two outcomes, which are poverty reduction and improvement of resource base. The project main focus is on conservation practices to ensure sustainable flow of water, while addressing issues related to poverty alleviation.

The PES project is as an attempt by the Government of Tanzania through WWF and CARE to improve the management of a substantial and long lasting conservation while alleviating rural poverty by giving special attention to increasing the participation of the rural poor in PES schemes as a view to contributing to poverty reduction. In this regard PSM was employed to assess the difference in welfare status between participants and non-participants.

The results from the Logistic regression indicate that; Age, Household sizes, asset ownership, land, availability of forest products are significant. Suggesting that household characteristics can have positive impact on the perception of the households. The participation variable is also found to be significant, implying that the households supported by PES are less likely to fall under the poor category. The study findings from the ANOVA analysis also show that; the existing difference in poverty status is as a result of the existence of the PES project in the study area. More so, from the perceptions of the households, the results show that the households are satisfied by the efforts of the PES project in regard to; improvement in their welfare, increase in the forest size and the availability of biodiversity. The impact of the project was also supported by the Multinomial probit regression results which found that the household who is in the project is more likely not to be poor.

From the results it was observed that households from the study area have benefited from PES project. The project has assisted several targets in this study, by providing them with bush knives, goats, hoes, tree and crop seedlings, and manure. Also the respondents were able to provide their views on how they perceive their standard of living before and after the project. From this it was found that there was difference between the two time periods. In assessing the availability of the resources after the PES project, it was revealed from the households that the project has an impact on the forest Biodiversity and size. Generally, material life of the households were found to be poor in case of houses and the construction material, where it was found that many houses in the study area are of poor quality and made of mud and poles in terms of wall materials, roofed with grass and having earth floors. Here the difference between the groups was found to be small.

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