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Evaluating the farmers Willingness to Accept Adoption of Watershed Conserving Land use Practices in Ndaka-ini Dam catchments, Muranga County, Kenya

Joram Kimenju Kagombe[1] Prof. James Kungu[2] Prof Daniel Mugendi[3] Joshua Kiplongei Cheboiwo[1*]
1.Socioeconomic, Policy and Governance, Kenya Forestry Research Institute, P.O Box 20412-00200, Nairobi, Kenya
2. School of Environmental Science, Kenyatta University, Nairobi, Kenya
3. Embu University, Embu, Kenya

Abstract
Payment for Ecosystem Service (PES) has become a handy tool for promotion of sustainable watershed management across the globe due its versatility and capacity to engage multiple stakeholders in the public and private sectors. Its strength lies in the ability to incorporate voluntary economic incentives and market-based instruments which are superior to the conventional command and control approaches in watershed and natural resource management. It is an incentive based mechanisms that links the suppliers and consumers of goods and services from a natural resource in a way that both parties contribute to improved delivery. It challenges the common perception that that water will always flow from the watersheds for free without any effort or investment to sustain such flows. To the contrary, water quantity and quality from watershed are deteriorating at unprecedented scale for farmers and other land owners hosting watersheds have not received recognition and incentives to play positive role in the land use management practices that ensure sustainable flow of water into the rivers. Nairobi City one of the fastest growing urban areas in east Africa has been experiencing serious water shortages partly to the reduced water inflows to Ndaka-ini Dam that suppliers 80% of its water supplies and further, its resident don't link the water from the pipes to conservation of water catchments areas. In recognition of the links between water catchments and water supply predicaments being experienced in Nairobi a study was commission whose objectives was to find out whether land owners and users of water are willing to participate in watershed protection scheme through Payment for Water Services. Specifically, the study identified factors that influence willingness of water users to pay for water provision and land use practices the farmers were willing to adopt to improve quality and quantity of water. Primary and secondary data were collected based on baseline survey and qualitative research approaches, interview schedules, questionnaires and, focus group discussions. Both parametric and non-parametric methods of data analysis were used. Results showed that farmers are willing to accept improved farming practices in return to for specified incentives. Though in most cases expected incentives were far above what the users were willing to give but a significant relationship between farmers' acceptance of conservation practice and incentives provided was established. The findings of the study provides some information that will guide future packaging of incentives for enhanced management and conservation of catchments areas for improved water quantity and quality of flows. The findings are relevant to many other water catchments beyond Ndaka-ini Dam hence are useful development PES schemes elsewhere in the country.
Keywords: PES, willingness to pay, watersheds, water, land use practices

1.0 Introduction

Forests worldwide form vital catchments for rivers that provide water for irrigation, domestic, industrial and power generation thus contributing to growth of the world economies. The Millennium Development Goals (MDGs) set the agenda for global world growth up to year 2015 (MDG, 2008). Goal number seven aimed at ensuring environmental sustainability with the set targets of integrating principles of sustainable development into country's policies and programme, reversing the loss of the environmental resource, reducing biodiversity loss, and reducing by half the proportion of the population without sustainable access to safe drinking water and basic sanitation by 2015. The report noted that 1.2 billion people in the world lived under conditions of physical water scarcity whose symptoms include, environmental degradation and competition for water. Though access to improved drinking water has expanded, nearly one billion people do without it and its use has grown at more than twice the rate of the population for the past century (MDG, 2008). However, failure to recognize the economic value of water has led to its unsustainable use and degradation of its natural base in many regions of the world (NCCRS, 2010).

Millennium development and sustainable development goals in Kenya were operationalized through government blue print contained in Vision 2030, which set a road map for the country's development. It aims at making Kenya a newly industrialized middle-income country with high quality of life for all citizens by 2030 (Vision 2030, 2007). Conservation of water catchments and development of water resources is covered under the

Water Act (2016) and the Forests Management and Conservation Act (2016). The Water Act provides a framework for development of water sector in the country with clear institutions for water providers, users and regulators. The Forests Act, provide a framework for involvement of the communities next to a forest resource in conservation and management while addressing the society needs. The main sources of water in Kenya are the commonly referred to five water towers namely; the Aberdares, Mt. Kenya, Mau, Cherangani and Mt. Elgon. The major threats to water towers are degradation, change in land use and unsustainable management practices (KFWG & DRSRS, 2009). Degradation has resulted in reduced water supply making Kenya to be classified as water scarce country, with water endowment at 400 m^3 per capita, which is far below the global UN benchmark of 1000 m^3 per capital (MEMR (2012).

To ensure sustainable conservation of water catchments areas, it's important to link the providers of environmental goods and services with the users. Payment for Ecosystem services (PES) which is the practice of proposing incentives to farmers/landowners or protected area managers in exchange for managing their land or resources, in exchange to providing some environmental service, provide this vital link (MEMR, 2012). The recently launched National Forest Program identified opportunity to apply PES schemes to protect and conserve forest ecosystems noting that government institutions have responsibility to promote PES and support partnerships as well as ensure enabling legal framework is in place (Ministry of Environment and Natural Resources, 2016). Adoption of conservation friendly measures in catchment areas could provide key to improving water flow and quality. This can be enhanced through provision of incentives to the participating farmers. The study aimed at identifying incentives to farmers and their willingness to accept such incentives.

Objectives of the study

i. Identify the environmental services farmers in Ndaka-ini area were willing to offer for conservation of the watershed.
ii. Determine Willingness To Accept for conservation incentives

1.1 Conceptual Framework

Payment for environmental services is a form of compensation paid by those who appropriate the benefits generated to those that preserve or conserve resources, ecosystems and environmental services related to the benefits. The principle guiding this relation is known as "protector – recipient". The concept of PES is based on the utilitarian approach in economics, specifically in the concept of "externality" (Cornes & Sandler, 1996). To achieve optimum forest cover, consumers of these services must compensate the producers of the positive externalities. To maintain forest cover, a mechanism in which all beneficiaries compensate producers of the services must be instituted. The forest conservation benefits national and international consumers, by carbon sequestration and biodiversity preservation, while the local and regional economy benefits through hydrological services and ecotourism benefits (Chomitz et al., 1998).

Land use system in place affects ecosystem service providers positively or negatively which in turn affects ecosystem service provision. Payment for environmental services by consumers will have a positive impact on service providers leading to better land use and improved ecosystem service. However, this payment is affected by the socio-economic status of the consumers of the service (Figure 1.1).

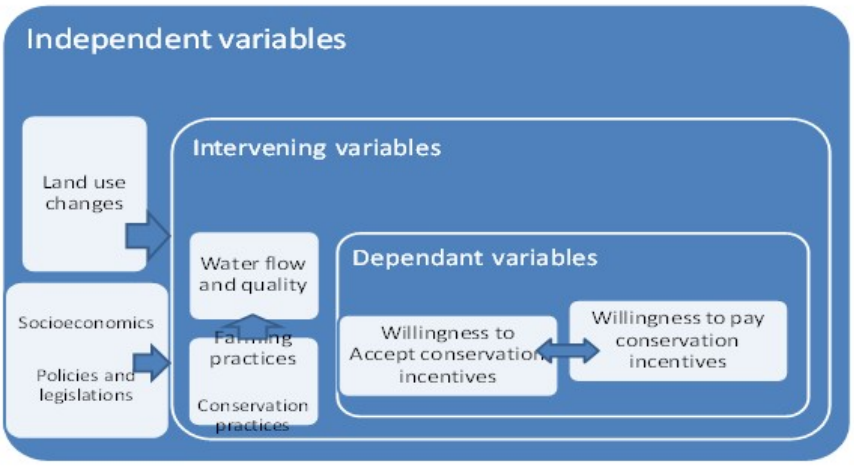

Figure 0.1: Conceptual Framework

Land use changes occasioned by changing socio-economic, environmental and infrastructure changes have had an impact on water flow and quality within the main rivers in the catchment. This has 'in turn' resulted to farmers and other stakeholders adopting various farming and conservation practices that have had a positive or

negative effect on water flow and quality. Payment for environmental services aims at influencing the adoption of friendly conservation practices by giving incentives to those contributing to conservation. It is important then to gauge the willingness of farmers to accept the incentives provided aimed at enhancing the conservation

2.0 Literature Review

2.1 Overview of Payment for Environmental Services

Ecosystems provide valuable services to local, regional and international community (Costanza et al., 1997; Millennium Ecosystem Assessment (MEA), 2005). However, traditional markets are underdeveloped or lacking in many environmental services such as watershed benefits, biodiversity conservation and carbon sequestration and hence decision to convert or alter the habitat fail to take into account the total service loss (Hanley, 1992; Loomis et al., 2000). When taken into account, these services may tip the scale in favor of environmental service particularly if the competing resource use such as agriculture and timber are only marginally profitable (Pearce & Moran, 1994; Pagiola et al., 2004). In cognizance of the worth of ecosystem services, 'Payment for Environmental Services" (PES) (also called ecosystem or ecological services) has emerged over the last decade as an approach that provides positive incentives to manage of ecosystems (Simpson & Sedjo, 1996; Landel-Mills & Porras, 2002). The incentives under PES may be used to compensate those presently providing an environmental service or those who have foregone some of their land use practices that are detrimental to provision of ecosystem service.

The key characteristic of PES deal is the focus to maintain flow of a specified ecosystem "service" — such as clean water, biodiversity habitat, or carbon sequestration capabilities — in exchange for something of economic value. The critical and defining factor of what constitutes a PES transaction, however, is not just that money changes hands and an environmental service is either delivered or maintained. Rather, the key is that payment causes the benefit to occur where it would not have otherwise thus becoming an "additional" to "business as usual," or at the very least, the service can be quantified and tied to the payment (Katoomba, 2008). The payment or incentive can take different forms such as; conservation easements (owner is paid to use and manage

defined piece of land only for conservation purposes), conservation land lease (owner is paid to use and manage land for conservation purposes for a defined period of time), conservation concession (public forest agency is paid to maintain a defined area under conservation uses only), community concession in public protected areas (individuals or communities are allocated use rights to a defined area of forest or grassland in return for a commitment to protect the area from practices that harm biodiversity), management contracts for habitat or species conservation on private farms, forests, or grazing lands (contract that details biodiversity management activities) and payments linked to the achievement of specified objectives (Katoomba, 2008).

Ecosystem service payments include both monetary and non-monetary transactions between an individual who offers services ("sellers") and an individual (or a group) who pays for maintenance of demanded services ("buyers"). The main characteristic of these seller/buyer transactions is focus on upholding a flow of a specified ecological "service," such as maintaining clean water, biodiversity and carbon sequestration capabilities. The transactions require regular, independent verification of sellers' actions and effects on the resources as a way of ensuring that the ecological service is indeed maintained—as buyers expect for their money (Katoomba, 2008). Payment of ecosystem services is identified as a direct and efficient way to promote conservation of biodiversity by bridging the interest of the local people and external actors (Wunder, 2006).

2.2 Issues Affecting Ndaka-ini Dam and Neighbouring Community

Farmers and the community surrounding the dam have in the past, raised concerns that have been addressed in various meetings. Some of the issues relate to community expectations that were yet to be realized and disputes between them and NWSC as summarized in Table 2.1.

Table 2.1: Key Ndaka-ini dam issues mitigation and strategies

	Issue	Details	Mitigation	Strategy
1	Seepage of effluents from the neighbouring shopping centre	Main shopping centre, Ndaka-ini, located next to the dam. It has no sewerage system so results to using septic tank that allows seepage to the dam	Provision of sewerage treatment facility	Relocate members from the centre and build sewerage treatment in other shopping centres
2	Soil erosion from different land uses	Siltation of rivers and dams	Construct coffer dam to control river flow and adopt best farm management practices	Desiltation should be carried out regularly in the dam
3	Depletion of raw water from competing uses	Result to low water levels in the dam	Assess water demands in all catchment areas, curb irrigated flower and other horticultural activities on the riparian areas of the dam and create awareness in designated water points	Water abstraction plan and enforcement
4	Unsustainable agricultural practices	Results to pollution from agrochemical siltation	Awareness creation on good conservation practices	Adopt best farming practices
5	Exotic tree species planted along the rivers	Eucalyptus trees planted along the rivers	Planting of trees friendly to water catchment conservation	Species site selection

Source: Ndeka reports, (2012)

3.0 Materials and Methods

3.1 Study Area

The study was carried out in the areas designated as catchment areas for Ndaka-ini dam which is located in Gatanga and Maragua districts, Murang'a County as shown in Figure 3.1. Gatanga District lies in longitude 36^{o} 44' 39.46" E and 37^{o} 00' 58.03" E and latitude 0^{o} 42' 13.28" S and 1^{o} 01" 12.72" S. The altitude is 1,340 -2,190 metres above sea level. It is in agro ecological zones UH0, UH1, LM1, UM1 and UM2 (MoA, Gatanga District, 2010). Water catchment areas for the dam include the entire Sub- locations bordering the dam and those situated between the dam and the forest of which Kimakia and Gatare forests stations are covered. The area of study included; Ndaka-ini, Makomboki, Kangari and Kariara sub-locations in Gatanga district and Makomboki and Kinyona sub-locations in Murang'a south district.

The study area is about 80 km north of Nairobi and 40 km west of Thika town on the slopes of Aberdare forest at the tip of Thika and Maragua districts in Murang'a County. The Ndaka-ini dam's catchment area measures 75 square kilometres. It consists of Kimakia and Gatare Natural forests which form Aberdare Ranges. The main rivers that drain into the Dam from this catchment are Thika, Githika and Kayuyu. Thika drains 50%, Githika 30% and Kayuyu 20% of the catchment into the Dam respectively (Athi Water Profile, 2015).

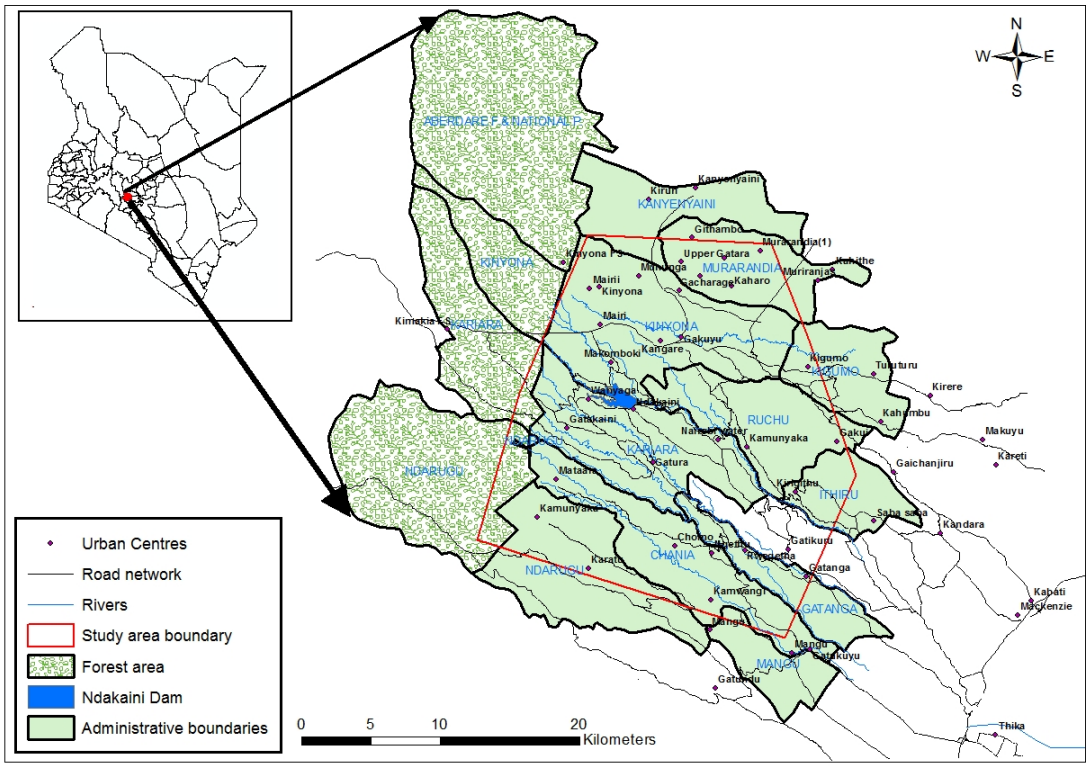

Figure 0.2: Location of the study area
Source: Kagombe and Kiama, (2012)

3.2 Genesis to Ndaka-ini dam

In the year 1988, the Kenya Government compulsorily acquired approximately 485.62 hectares of land to create space for the construction of Thika Dam (Ndaka-ini) that was to supply portable water to the residents of Nairobi City and its environs. When full, about 242 ha of land acquired were under water. The rest of the land was used to provide construction site for extraction of quarry stones at Kiruga construction site for the installation of Thika River gauging station for river compensation monitoring and construction sites for raw water intakes at Kiama river portal, Kimakia river shaft and Chania river outfall respectively.

The key functions for the dam were; harness water from the dams catchment to the reservoir, supply continuous reliable water to the City of Nairobi and its environs with minimum interruptions at regulated quantities, release regulated quantities of compensation water downstream to maintain the natural Thika river course, encourage afforestation within the dams catchment and around the dam to sustain the catchments and ensure the presence of an environment for continuous water flow, collect and analyse embankment instrument data using computer programmes to ensure the safety of the earth fill embankment, carry out physical analysis on stored water to establish its quality and monitor, collect data and keep records of the weather changes around the dam. The dam has a reservoir volume of 70,000,000 m^3 with average depth of 65 metres, water surface area of 280 ha and a catchment area of 75 km^2 consisting of Kimakia and Gatare natural forests which are part of Aberdare ranges. The dam is owned by Athi water board which has leased it to NCWSC (African Development Bank, 1998).

3.3 Demography

The catchment area has high population density area, where many small towns and market centres have sprung up. This has led to land fragmentation and dwindling land sizes. The study area consists of 7484 households comprising of; 2204, 1797, 943, 723, 703, 684, 412, 18 in Makomboki, Kinyona, Kimandi, Karangi, Mbugiti, Ndaka-ini, Kanunga and Kimakia sub-locations respectively. Average population density is 390 persons per km square (KNBS, 2010).

3.4 Land Use

The upper dam catchment is the forest reserve, which is managed by the Kenya Forest Service and below it is the Nyayo Tea Zone. Below the tea zone are the smallholder tea farms, with intensive tea farming and animal

husbandry. There are also smallholder farms with kales (*sukuma wiki*) and other vegetable varieties. Coffee growing and subsistence farming is practiced in the lower parts of the dam.

3.5 Description of the Catchment

To the south of the dam is the Ndaka-ini Township, which is spreading southwards towards Gatura. To the west of the dam is Kimandi town and northwest is Wanyaga town. To the north of dam is the Kimotho market and the east is Makomboki and the tea factory. The terrain is very steep above 45^0 with loose soils that are susceptible to land- slides. There is intensive tea farming and dairy cattle keeping, with pockets of napier grass planted on the edges of the rivers.

3.6 Sampling Design

3.6.1 Household Sampling

The area was stratified into government forested area, individual farmers in the water catchment areas situated in the upper side of the dam classified as water producers and farms in the lower catchments classified as water consumers. In the upper catchment, stratification was based on the households within one kilometre from the dam and ridges from the dam to the forest area. Systematic sampling was used to choose households within a stratum. The target population for the farmers in the catchment areas was the number of households in the range of one kilometre all around the dam and those in the ridges that supply water to the dam up to the forest area. The size of the sample size was determined as described by Fisher et al., (1983) and expounded by Mugenda and Mugenda (2003). Stratified random and cluster sampling was used as described by CABI (2004).

3.6.2 Research Method

The socio-economic survey was used to collect information on the willingness of farmers to adopt conservation activities that would improve watershed management . Data collected included socio-economic status, costs, and conservation activities. In addition, opportunity costs for conservation activities were determined through contingent valuation method which is a survey-based approach used to measure the non-market values of environmental or public goods based on how an individual responds to a question on his/her WTP to environmental changes (Hoevenagel, 1994; Stewart & Khan, 2006). The two principal assumptions underlying this method are: (1) that people have well-ordered, but hidden, preferences for all kinds of environmental goods; and (2) that people are capable of transforming these preferences into monetary values (Hoevenagel, 1994). On the basis of these assumptions, the CV method elicits values for environmental goods by presenting respondents with a description of a proposed hypothetical scenario or environmental change and asks the respondents to express (in monetary terms) their Willingness –To –Accept (WTA) to reduce a negative change.

The study used both primary and secondary data sources. Primary data were obtained from the study sites by use of semi-structured interview schedule, questionnaire and Geographical Information System (GIS). Primary data included; socio-economics household information, land use changes, conservation activities, willingness to adopt conservation practices, willingness to pay for ES, institutional and legal framework for PES.

Interviews were administered to land users and foresters in the dam catchments area, water users, key informants, managers of institutions supplying water, large consumers of water, tea factories and water treatment companies. The issues captured during water supplier interviews included socio-economic data affecting the households, land use practices, conservation activities, threat to water catchments, incentives to conservation, farm size changes over time and level of soil and water conservation related activities. In addition transect walks were conducted along the main rivers feeding the dam to determine land cover in riparian areas.

Secondary data was collected from reports, books, public records, data sets held by institutions. These included; rainfall trends, intake and outtake of water in the dam, development planning, on-farm tree planting, infrastructure growth, community structures, livelihood options for the farmers, policy and legal frameworks, household characteristics, history of the dam, trends of water use by consumers and challenges in water provision.

4.0 Results and Discussion

4.1 Demographic of the Respondents

4.1.1 Gender and Age of the Respondents

The study targeted a sample of 339 water consumers in the lower Ndaka-ini catchment . Out of the 337 heads of households in upper Ndaka-ini, 54.3% were males while 45.7% were females. Majority of the respondents (69%) were 50 years with most respondents in the 31 to 50 years age bracket. Few youth (3.6%) participated in the survey.

4.1.2 Education Level of Respondents

Most household heads had attained either primary or secondary education level, with 47.8% heads of households with primary education, 37.7% had secondary education, and 9.5% had college education while 0.9% had attained university qualifications as shown in Table 4.1. Chi-square test showed that there were no gender

differences in education level attained, at $p<0.05$ level. This shows that both males and females did not differ significantly in education level attained. The community had high literacy level with only 4.2% respondents with no formal education.

Table 4.1: Heads of households education level versus gender in Ndaka-ini

Education level	Gender				Total		Chi- square statistics
	Male n	%	Female n	%		%	
No formal education	6	2	8	2	14	4.2	χ^2=5.513
Primary	80	24	81	24	161	47.8	
Secondary	73	22	54	16	127	37.7	df=4
College	22	6.5	10	3	32	9.5	
University	2	0.5	1	0	3	0.9	
Total	**183**	**54**	**154**	**46**	**337**	**100**	Sig.=0.239

Not significant at p<0.05 level

Farmers' ability to acquire, process and use information can be increased by education as education has been shown to be positively correlated with farmers Willingness-To- Pay (WTP) and Willingness-To-Compensate (WTC) for improved land and water management practices (Tegegne, 1999; Asrat et al., 2004). Education is expected to reflect acquired knowledge of environmental amenities and as established by Zbinden and Lee (2005), level of education of the household decision maker determines their ability to obtain and process information and to implement knowledge intensive conservation practices and agricultural technologies.

4.1.3 Household size in Ndaka-ini Water Catchment

Results from Table 4.2 show that 41.5% of respondents were living with 6-10 people, 39.2% were living with 1-5 people in their houses, while 5.6% indicated that they lived with more than 15 people in their houses.

Table 4.2: Household size for farmers in Ndaka-ini water catchment area

Household size	n	%
1-5	132	39.2
6-10	140	41.5
11-15	46	13.6
Above 15	19	5.6
Total	**337**	**100.0**

Household size was below the ones reported in 2009 population census that indicated 50.4% of households in Murang'a county had 1-3 persons per household (Wiesmann et al., 2014). Size of household is related to number of children per household. Household sizes have been shown to have a direct positive effect on the household water consumption (Hanke & Maré, 1984; Lyman, 1992).

4.1.4 Main Occupation of Respondents

The main occupation of house heads (92.0%) respondents were farmers, 4.2% were government employees whereas 0.6% were employed in the private sector. The survey targeted farmers and farming practices implying that majority of respondents were the desired target and so the follow-up responses were likely to achieve desired results. Farmers are the key determinants in success of PES as they are expected to make major decisions on willingness to accept incentives in conservation.

4.1.5 Land Ownership Status in the Study Area

Results on land ownership showed that majority (97.6%) of the respondents owned individual land parcels while 1.8% had family land, with very little land under communal ownership. Land tenure has been shown to have influence on management of natural resources with many environmental problems such as soil degradation and forest depletion characterized as a result of incomplete, inconsistent and non-enforceable property right (Bromley & Cernea, 1989; Watchter, 1992). In addition, potential for PES is more favourable in individual land ownership as it gives continuity of service provision for a long time (Wunder et al., 2005). This shows that land ownership in Ndaka-ini was favourable to PES implementation.

4.1.6 Location of Farms from the Dam and Forest Edge

The study sought to find out the location of respondent farms from the dam and the forest edge as shown in Table 4.3. Majority of respondents' farms (54.3%) were located within 5km from the dam while 19.3% were located in between 6 to 10 km from the dam. On the other hand 38%, of respondents' farms were located within 5km from the forest edge while 22.2% were located within 6 to 10 km from the forest edge. Chi-square test results shown in Table 4.3 revealed that there was a significant relationship between distance of the farm from Ndaka-ini dam edge and forest reserve border, at $p<0.05$ level. This implies that majority of the farmers were not far from the Ndaka-ini dam and forest reserve border. Proximity from the dam and forest could determine the farmer dependency on the ecosystem with those near the forest being more dependants. It could also affect the sediment load going to the dam that is due to farmers' farming practices. On the other hand, proximity to the dam may affect respondents understanding of the relationship of the dam to livelihood of the community and

their understanding on the same.

Table 4.3: Distance from Respondent Farm to Forest Reserve and Ndaka-ini Dam

Distance of the farm from Ndaka-ini dam edge (KM)	Distance farm from forest reserve border (KM)						Total No.	% Total	Chi-square statistics
	1 to 5	6 to 10	11 to 15	16 to 20	21 to 25	26<			
1 to 5	91	46	18	11	5	12	**183**	**54.3**	χ^2=121.773
6 to 10	27	12	13	11	2	0	**65**	**19.3**	
11 to 15	3	9	12	14	7	0	**45**	**13.3**	
15 to 20	2	4	8	7	2	2	**25**	**7.4**	df=25
21 to 25	3	1	1	1	6	0	**12**	**3.6**	
26 and above	2	3	0	2	0	0	**7**	**2.1**	
Total	**128**	**75**	**52**	**46**	**22**	**14**	**337**		Sig.=0.000*
% total	**38**	**22.2**	**15.4**	**13.6**	**6.5**		**4.2**	**100**	

***Significant at *p*<0.05 level**

4.2 Main Crops Grown in Ndaka-ini Catchment and in riparian areas

Results in Table 4.4 showed the main crops grown by the households in the farms, segregated into crops grown next to the river, those grown in the mid-slopes and those grown in upper slope. Main crops grown next to the river were trees and vegetables, while tea and maize were grown in mid-slope and upper slope. Results showed that, for those who planted crops next to the river, 25.5% planted trees, 24% planted vegetables, 13.6% planted tea, and 12.8 % planted napier grass while 10% planted maize. For those who planted crops in the mid slope, 34.7% farmers planted tea, 29.7% planted maize, and 9.5% planted napier grass whereas 15.7% planted trees. Among the respondents who planted their crops in the upper slopes, 37.7% planted tea, 35.9% planted maize and 9.2% planted trees. Most respondents (72.4%) planted tea in mid and upper slope, while trees and vegetables were planted along the river.

Table 4.4: Proportion of Vegetation grown in Ndakaini

Position in the slope	Proportion of vegetation (%)						Total
	Tea	Maize	Vegetables	Napier grass	Trees	Others	
Next to river	13.6	10.1	24	12.8	25.5	14	100
Mid slope	34.7	29.7	1.5	9.5	15.7	8.9	100
Upper slope	37.7	35.9	0.6	7.4	9.2	9.2	100

A cross tabulation was done to compare vegetation grown next to the river with mid slope and upper slope; and then vegetation in mid slope and that in upper slope as shown in Table 4.5. Chi-square test results showed significant differences in crops grown next to the river, in the mid slope and in the upper slope, at p<0.05 level. Location of crops within the slope is likely to have implication on sediment load going into the rivers due to the tilling method applied and resultant soil erosion after the rains. Soil conservation measures such as grass strips lead to reduced sediment load to the rivers (PRESA, 2011). The main challenge in the area was vegetation planted along the rivers as the mid and upper slopes were mainly covered by tea. Payment for ecosystem service in the area should address interventions that reduce sediment loads focusing mainly in vegetation planted along the rivers and soil conservation measures practised in the farm.

Table 4.5: Crops grown in different parts of the farm in the study site

Crops grown next to the river	a) Crops grown in the mid slope						Total No	% No.	Chi-square statistics
	Tea	Maize	Vegetables	Napier grass	Trees	Others			
Tea	15	17	1	1	12	0	46	13.6	χ^2=379.882
Maize	5	2	1	0	26	0	34	10.1	
Vegetables	22	34	2	9	14	0	81	24	
Napier grass	19	21	0	3	0	0	43	12.8	
Trees	53	13	1	19	0	0	86	25.5	df= 25
Others	3	13	0	0	1	30	47	14	
Total	**117**	**100**	**5**	**32**	**53**	**30**	**337**	**100**	Sig.=0.000*
Next to the river	**b) Crops grown in the upper slope**						**Total No.**	**% No.**	**Chi-square statistics**
	Tea	**Maize**	**Vegetables**	**Napier grass**	**Trees**	**Coffee**	**Others**		
Tea	15	23	0	6	2	0	0	46	13.6	χ^2=354.108
Maize	4	13	1	1	15	0	0	34	10.1	
Vegetables	41	30	0	9	1	0	0	81	24	
Napier grass	2	27	1	0	13	0	0	43	12.8	
Trees	50	27	0	9	0	0	0	86	25.5	df= 30
Others	15	1	0	0	0	1	30	47	14	
Total	**127**	**121**	**2**	**25**	**31**	**1**	**30**	**337**	**100**	Sig.=0.000*
In the mid slope	**c) Crops grown in the upper slope**						**Total**	**% No.**	**Chi-square statistics**
	Tea	**Maize**	**Vegetables**	**Napier grass**	**Trees**	**Coffee**	**Others**		
Tea	67	32	1	2	14	1	0	117	34.7	χ^2=510.179
Maize	51	41	1	6	1	0	0	100	29.7	
Vegetables	1	4	0	0	0	0	0	5	1.5	
Napier grass	4	12	0	16	0	0	0	32	9.5	df=30
Trees	4	32	0	1	16	0	0	53	15.7	
Others	0	0	0	0	0	0	30	30	8.9	
Total	**127**	**121**	**2**	**25**	**31**	**1**	**30**	**337**	**100**	Sig.=0.000*
%	**37.7**	**35.9**	**0.6**	**7.4**	**9.2**	**0.3**	**8.9**	**100**		

***Significant at p<0.05 level**

4.3 Soil Conservation Measures in Ndaka-ini Catchment

The study revealed the types of soil conservation measures practised in the study area as shown in Table 4.6. Results showed that 22.6%, 18.1%, and 14.5 engaged in tree planting, terraces and contour planting respectively. Other conservation measures practised were hedge row planting, grass strips farming and contour digging. Results showed that 91.1% of the respondents were practising some form of conservation in their farms.

Table 4.6: Type of Conservation Measures Farmers are Practicing in the Study Area

Type of conservation measures	n	%
Tree planting	76	22.6
Terraces	61	18.1
Contour planting	49	14.5
Hedge rows planting	43	12.8
Grass strip planting	39	11.6
Contour digging	39	11.6
No response	30	8.9
Total	**337**	**100.0**

For PES to be successful there is need to consider conservation preferences of landholders and land managers targeted for participation (Kaczan et al., 2012). Environmental management measures that are locally prioritized and implemented using participatory approach have been shown to be effective in tackling environmental problem (Balana et al., 2010; Baland & Platteau, 1996; Herath, 2004; Ostrom, 1990). Studies in Kapingazi showed that farmers preferred adoption of riparian area management by removing eucalyptus planted along the rivers, capacity building on good environmental practices and diversification of income base by

introducing nature-based enterprises like bee keeping that would lead to a win-win in economic and environmental impacts (Balana et al., 2011).

Conservation practice in place may determine the adoption rate of introduced technology due to the past experiences farmers will have gained on the same. Payment for environmental service is dependent on farmers adopting best management practices that can improve soil conservation practice and lead to reduced sediment load (PRESA, 2011). Studies in Sasumua showed that contour farming combined with grass strips had highest effects of reducing sediment load, followed by terracing, contour farming and grasses waterway (Namirembe et al., 2013). As a result, working with farmers who had prior knowledge on conservation practices as depicted was a good entry point for PES.

4.4 Threats to water conservation

The study sought to know threats to conservation of water catchment areas. Table 4.7 shows consumers' responses on threats at water catchment areas.

Table 4.7: Response to consumers' in lower parts of Ndaka-ini on threats to water catchment areas

Threats to water catchment areas	n	Percent
Unfriendly trees	29	25.0
Climate change	19	16.4
Drought	15	12.9
Deforestation	14	12.1
Riparian cultivation	12	10.3
Lack of awareness	12	10.3
Poor farming practices	6	5.2
Land size	4	3.4
Pollution	3	2.6
Policies	2	1.7
Total	**116**	**100.0**

As shown in Table 4.7, 25.0% of the water consumers reported that major challenge faced at water catchment areas was environment unfriendly tree species like *Eucalyptus* that led to drying up of water catchment areas. It also led to reduction of aquatic organisms that depend on critical thresholds of water (Dugan et al., 2010). Irregular climatic change was another threat that was reported by most farmers. According to 16.4% of the water consumers, climatic change threatens the survival of species and the integrity of ecosystem. For instance, global warming has led to increased rainfall in some areas, with others experiencing severe droughts. An increasing frequency of climate extremes like floods and drought is aggravating the state of the available freshwater resources. Furthermore, two similar proportions (10.3%) of the respondents indicated that cultivation of riparian areas and lack of awareness among farmers, were other major threats at water catchment areas respectively. This implied that lack of awareness among the community members on importance of conservation of catchment areas negatively influenced farmers' utilization of watershed resources.

4.5 Willingness to Accept Conservation measures

To establish farmers' willingness to adopt conservation methods in return to incentive, farmers were presented with four hypothetical options and requested to rate the option they could adopt. The four options are presented in Table 4.8.

Table 4.8: Land use options presented to farmers in Ndaka-ini

Attributes	Options			
	Option 1	**Option 2**	**Option 3**	**Option 4**
1. Land area to be committed	10% of your land	20% of your land	40% of your land	10% of the land
2. Length of commitment period	5 years	15 years	30 years	30years
3. Right to harvest products (grass/fodder/beekeeping)	Permitted	Partially permitted	Not permitted	Not permitted
4. Reward scheme/incentive scheme	Provide and/or waive annual **water cost** for domestic use and/or irrigation per acre of land committed	Provide **micro-scale electricity** and/or waive 50% of your annual electricity cost per acre of land committed	Direct annual cash payment of Kshs. 4500 per acre of land committed	Paid carbon fund for every tree existing
5.Local scheme administering agent	Water Resource Users Association	Focal Development Area Committee	Community Forest Association	CFA
6. Required free labour contribution related to the contractual scheme (training, attending scheme meetings; etc.) per month	1 day	2 days	3 days	3

The participants in the survey rated the hypothetical options presented to them as shown in Table 4.9.

Table 4.9: Ratings of hypothetical land management by farmers in Ndaka-ini

In conjoint survey	Take option 1		Take option 2		Take option 3		Take option 4	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
I would not undertake such an agreement under any circumstances	97	28.8	233	69.1	278	82.5	267	79.2
The agreement is not acceptable, but has one or two good points	40	11.9	63	18.7	36	10.7	46	13.6
I am indifferent to the agreement.	20	5.9	23	6.8	15	4.5	13	3.9
The agreement is good and I would undertake it if one or two points are changed	82	24.3	13	3.9	5	1.5	4	1.2
I would definitely undertake such an agreement.	98	29.1	5	1.5	3	0.9	7	2.1

Table 4.9 shows rating of the hypothetical land management arrangement. For option 1, 28.8% respondents would not undertake such an agreement under any circumstances, 24.3% stated that the agreement was good and they would undertake one or two whereas 29.1% stated that they would definitely undertake such an agreement. With regard to the 2nd option, most (69.1%) of the respondents indicated that they would not undertake such an agreement under any circumstances while 18.7% felt that the agreement was not acceptable but had one or two good points. However, 1.5% respondents confirmed that they would definitely undertake such an agreement.

In relation to the 3rd option, majority (82.5%) of the respondents would not undertake such an agreement under any circumstances, 10.7% stated that the agreement was not acceptable but had one or two good points, 4.5% respondents were not sure about the agreement, 1.5% indicated that the agreement was good and they would undertake it if one or two points are changed whereas 0.9% respondents stated that they would definitely undertake such an agreement. For option 4, a large proportion (79.2%) of the respondents reported that they would not undertake such an agreement under any circumstances.

Comparing results with options presented in Table 4.8, it emerged that most of the farmers indicated that they would take an agreement if given the first option attributes, that is, commitment of 10.0% of the land for a period of 5 years with the right of harvesting farm products, waiver of annual water cost for domestic use and/or irrigation per acre of land committed, ensuring that they use local scheme administering agent and attending scheme meetings or training one day per month. However, majority of the respondents stated that they would not undertake such an agreement under any circumstances if given options two, three and four. Results showed that farmers go for a package of incentives but not necessarily just cash especially those that can raise their farm productivity. A similar study in East Usambara Mountains in Tanzania showed that the nature of payment greatly influences likely participation rate. Individual payment was found to be more effective than group payments. In addition, the study showed the required amount of payment to be highly variable between farmers (Kaczan et al., 2012). The results are in line with studies conducted in Kapingazi, Embu Kenya that showed farmers' preference was dependent on size of land area to be committed for conservation, length of scheme and

restrictions on right to harvest produce from the farm (Balana et al., 2011).

Researchers in PES argue that of the five mechanisms available for ensuring the provision of ecosystem services – prescription, penalties, persuasion, property rights and payments – only payments are likely to be effective at the global level. To distribute the funds, the researchers recommend a system modelled on Brazil's ICMS Ecológico 2, which they consider cost-effective and successful. Under this intergovernmental fiscal transfer system, Brazilian states return 25% of revenue from sales taxes to the municipalities. Some states use this to pay for ecosystem services. For example, the state of Parana awards 5% of this revenue each year to municipalities in proportion to their protection of watersheds and conservation areas. This has created incentives for municipalities in Parana to develop well-managed protected areas, especially as only the best efforts are rewarded, so municipalities in effect compete with each other for the funds. As has been the case for the ICMS Ecológico, criteria can be simple in the initial stages but improved over time as data and information improve. They argue that whatever approach is taken, payments should target bundled services as this can be substantially be more cost-effective. Provision of services and products using PES can offer multiple benefits for forests by generating revenues for sustainable forest management initiatives and promote behaviors that protect forest communities from some of the threats that they are currently facing (Hoogeveen et al., 2008).

Duration of commitment influences acceptance with most farmers preferring short-time commitment. Further results showed that most farmers were willing to participate in a form of scheme that relates to PES as shown in Table 4.10 but differ in details of implementation.

Table 4.10: Participation rate in contingent valuation scenario for farmers in Ndaka-ini

Would you participate in the scheme?	**n**	**Percent**
Yes	279	82.8
No	58	17.2
Total	**337**	**100.0**

As shown in Table 4.10, majority (82.8%) of the farmers were willing to participate in the scheme while 17.2% were not willing to participate. This showed PES was received positively in the area but details of the mode of the concept engagement required to be worked out. This compares well with study conducted in Sasumua that showed that 91% of community members were willing to accept payment of US$938/ha/year (Namirembe et al., 2013).

Significant number of farmers in Ndaka-ini dam catchment area would accept environmentally friendly conservation practices in exchange to incentives provided by water providers and consumers. Results from Table 4.11 showed that 67.7% of farmers would not take an agreement under any circumstance, 12.4% stated that they would not take option 3, 68 stated option 4 while 62 cited option 2. Among the 28 who would take an agreement, majority of them (21) indicated that they would take an agreement if given first option attributes; that is, commitment of 10.0% of the land for a period of 5 years with the right of harvesting farm products, waive annual water cost for domestic use and/or irrigation per acre of land committed, ensuring that they use local scheme administering agent and attending scheme meetings or training one day per month.

Table 4.11: Ratings of hypothetical land management options by farmers in Ndaka-ini

	Presented option				**Total**		**Chi-square statistics**
	Option 1	**Option 2**	**Option 3**	**Option 4**		**%**	
Would not take	22	62	76	68	228	67.7	χ^2=135.076
Agree with two points	13	17	7	5	42	12.4	
Indifferent	8	4	0	4	16	4.7	df=12
Agree with most points	20	1	0	2	23	6.8	
Would undertake	21	0	1	6	28	8.3	
Total	**84**	**84**	**84**	**85**	**337**		Sig.=0.000*

*Significant at p<0.05 level

A Chi-square test was used to find out whether there was a significant relationship between farmers acceptance of environmentally conservation practices and incentives given by water providers. The results of the analysis revealed that there was a significant relationship between the two variables (χ^2=135.076, df =12, p=0.000). This implies that farmers' acceptance offer of setting aside a riparian buffer zone is greatly influenced by the incentives given by water providers.

In an attempt to probe acceptable amount of cash incentive, farmers were required to indicate levels of incentives that would make them take PES initiative as shown in Table 4.12.

Table 4.12: Compensation amounts farmers were willing to be paid to join PES scheme

Amount compensated	Yes		No		Not applicable	
	n	%	n	%	n	%
Kshs 5, 000($50)	0	0.0	279	82.8	58	17.2
Kshs 10, 000($100)	13	3.9	266	78.9	58	17.2
Kshs 20, 000($200)	21	6.2	258	76.6	58	17.2

Table 4.12 shows the amount of money farmers would like to be compensated in order to participate in the scheme. All the farmers who were willing to participate in the scheme reported that they would not participate if compensated Kshs. 5,000 ($50)per year. However, 3.9% farmers reported that they would participate if compensated 10, 000 while 6.2% farmers indicated that they would participate if compensated Kshs. 20,000($20). This showed that the amounts of money farmers were compensated had a great impact towards their willingness to participate in the scheme. This related to the annual income of households in the area who are predominantly in tea farming which gives high returns. A similar study conducted in Nairobi showed the mean WTP was about Kshs. 275 per month, approximately equivalent to US$3. This was almost 25% of the average survey household's monthly water bill. This apparently large WTP value reflected the extent of water shortages in the survey area and people's preferences to pay for reliable water supply. The study showed a wide variation households' water bills (from Kshs. 120 -900 i.e., approximately from US$ 1.5 to 11.25 per month) and likewise a wide variation in WTP (Balana & Catacutan, 2012)

4.6 Type of incentives

Farmers were more willing to accept rewards in kind as shown in Table 4.13.

Table 4.13 shows proposed reward system that gives farmers incentives to participate in conservation activities. Majority (47.8%) of the farmers reported that provision of water supply could influence their participation in water conservation activities, 11.0% indicated carbon credit while 10.7% indicated power supply. Other reward systems mentioned included water pumps and storage tanks, fodder provision, tree seedlings and firewood supply. The type of reward was consistent with earlier baseline information that showed that most of farmers around the dam were not connected with tapped water.

Table 4.13: Incentives farmers were willing to take to participate in conservation

Reward system	n	Percent
Water supply	161	47.8
Carbon credit	37	11.0
Power supply	36	10.7
Firewood provision	33	9.8
Tree seedlings	26	7.7
Fodder provision	23	6.8
Water pumps and storage tanks	21	6.2
Total	**337**	**100.0**

4.7 Effects of the Dam on Community Livelihoods

The study further sought to determine effects of the dam on livelihoods. To address this, household heads were asked to indicate whether they benefited from the dam or not. In response, 16.9% respondents reported that they benefited while 83.1% respondents indicated that they never benefited. Table 4.14 shows the positive effects of the dam.

Table 4.14: Positive effect of Ndaka-ini dam on the neighboring community

Positive effects of dam	n	Percent
Infrastructure development	34	10.1
Water supply	16	4.7
Tourism	4	1.2
Employment	3	0.9
None	280	83.1
Total	**337**	**100.0**

As indicated in Table 4.14, some respondents indicated that the major positive effects of the dam were infrastructural development (10.1%), water supply (4.7%) and attraction of tourist (1.2%). However 83.1% indicated that there was no positive effect of the dam. This is a major area of concern as it relates to the perception of the community neighbouring the dam. In one of the interview with a farmer neighbouring the dam, he indicated that they do not see any benefit from the dam and went ahead to suggest that they would be better off if the dam was drained off. The NWSC in partnership with other agencies managing the resource should address the issue by developing community outreach programs. Payment for environmental services could

provide a good entry point towards providing incentives which would improve linkage of the community and the water resource. Table 4.15 illustrates the negative effects of the dam.

Table 4.15: Negative effect of the Ndaka-ini dam to the neighboring community

Negative effects of dam	n	Percent
Extreme coldness	200	59.3
Reduced land size	55	16.3
Malaria preference	43	12.8
Damage food crops	32	9.5
Security threat	7	2.1
Total	**337**	**100.0**

As shown in Table 4.15, 59.3% of the respondents indicated that extreme coldness was one of the negative impacts of the dam. Other negative impacts mentioned were; reduced land size, malaria preference, damage of the food crops and security threat. In a focus group discussion with CFA members, they indicated that due to change in weather pattern, they no longer plant crops like cabbages that used to do well in the area before. Keeping of livestock has also reduced and those who keep them incur higher cost of treatment. The dam also separated community members who used to reside together and cut them off from schools, health centres and shopping centres. There were earlier promises to set up schools and health centres but these are yet to be actualized.

Table 4.16 provide the opportunities of the dam to the improvement of the life of the community.

Table 4.16: Potential for Ndaka-ini dam to the improve community livelihoods community

Opportunities	n	Percent
Water supply	174	51.6
Power supply	86	25.5
Fish provision	35	10.4
Eco- tourism	14	4.2
Water for irrigation	13	3.9
Health centres	10	3.0
School bursaries	5	1.5
Total	**337**	**100.0**

The improvement of the dam has brought about some opportunities in the community. As reported by the household heads, 51.6% indicated that construction of the dam has led to water supply in the community, 25.5% indicated it has led to power supply while 10.4% indicated that it created jobs since some members of the community engaged in fishing activities.

5.0 Conclusions and Recommendations

5.1 Conclusions

The study of small scale water users in Gatanga Sub-County in Murang'a County and in Thika town in Kiambu County for large-scale water users showed that farmers were willing to accept incentives in return to adoption of environmentally friendly conservation practices. It was established that farmers would generally go for a package of incentives that could increase their farm productivity but not necessarily payment of cash incentives. The duration of commitment in a conservation initiative affected acceptance level with most farmers preferring short periods. There was significant relationship between farmers' acceptance of conservation practice and incentives provided. However, the cost incurred by farmers in adopting the friendly environmental practices was much higher than incentives offered. This calls for consideration of mix or combination of rewards with additional incentives especially those that could lead to improved productivity of land at the household level. Land tenure was favorable to PES as 97.6% of land was privately owned.

5.2 Recommendations

Farmers Engagement: Farmers in PES schemes can be engaged using a combination of incentives such as in-kind supported by a proportion of cash rewards. Conservation practices that should be sold out to farmers are terracing, contour farming, planting of grass-strips and planting bamboo along the rivers. Farmers' awareness towards conservation should be enhanced to improve uptake of PES packages. In addition, cost benefit analysis for adopting different conservation practices need to be done to inform partners decisions to participate or not.

Mechanism for passing on incentives: The collection point for the incentive would be through water bills charged by Water Company. To reach the supplier of the service, there would be need to develop a very clear mechanism on how the incentives will be passed over while also developing a monitoring system to ensure compliance. Experience from Brazil showed that payment was the most effective tool with 25% of revenue being reinvested to support PES.

Types of incentives: To promote PES use of existing rewards for conservation can be adopted but there may be need to reorganize them to include conditionality so as to gain the additionality out of the provided incentives. In addition, there is need to develop a robust framework for tapping incentives provided by users and channellin them service providers or catchment stewards. Where possible, its more appealing to promote bundled approach in ES as it's more cost effective.

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