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VULNERABILITY ASSESSMENT OF SOIL AND WATER CONSERVATION ADOPTION IN TWO SUBWATERSHEDS OF THE NZOIA BASIN, KENYA

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Heather Elisabeth Patt

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VULNERABILITY ASSESSMENT OF SOIL AND WATER CONSERVATION ADOPTION IN TWO SUBWATERSHEDS OF THE NZOIA BASIN, KENYA

By

Heather Elisabeth Patt

A THESIS

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ABSTRACT

VULNERABILITY ASSESSMENT OF SOIL AND WATER CONSERVATION ADOPTION IN TWO SUBWATERSHEDS OF THE NZOIA BASIN, KENYA

By

Heather Elisabeth Patt

In western Kenya, land use activities in two subwatersheds of the Nzoia Basin typify maize production potential and its cultural significance. Conditions in the upper watershed contributed to soil erosion and reduced soil fertility, which affected local livelihood conditions and water quality conditions in Lake Victoria. Research objectives included: (1) identification of soil and water conservation (SWC) practices, (2) determinants to SWC adoption, and (3) livelihood vulnerability conditions that encourage SWC adoption in the Kapolet and Moiben subwatersheds. Data were acquired through participatory rural appraisal activities (n=4), key informant interviews (n= 8), household questionnaires (n=172), and personal observation. Household respondents indicated that 59% apply organic fertilizer, 56% plant grass strips, 29% build terraces, and 29% leave land fallow. Determinants to SWC adoption included perception of soil conditions, knowledge, agricultural extension services, and accumulation of wealth assets (e.g., livestock, title, acreage). Cattle theft was a major risk identified in the Kapolet region, which affected grass strip usage. Water shortage was a major risk in the Moiben region, which contributed to low SWC adoption because assets were invested in securing water. If implemented, specific SWC methods may act to prevent erosion and subsequent loss of soil fertility. Identifying opportunities to increase farmers' capacity to adopt conservation practices may contribute to meeting high maize production demands from this region, while also improving local and regional soil and water quality.

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I would also like to acknowledge my graduate committee members Dr. Geoffrey Habron, Tracy Dobson JD and Dr. Jennifer Olson for their guidance. Thank you to my friends and family who shared in my excitement of being able to return to Kenya to work on a watershed project.

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THESIS PURPOSE AND ORGANIZATION

This thesis examined the elements of livelihood vulnerability within the context of soil and water conservation activities in two subwatersheds in the upper highlands of the Nzoia River, Kenya. Data collected represented one aspect of a multi-institutional Aquaculture Collaborative Research Support Program (CRSP) project titled "Hydraulic, Water Quality and Social Assessment of the Nzoia Basin, Kenya Fishery." The purpose of the project was to study the physical, biological and social conditions that contributed to deteriorating water quality conditions in Lake Victoria. Funding for this project was from the United States Agency for International Development (USAID) Grant No. LAG-G-00-96-90015-00, and by participating institutions (Michigan State University, East Lansing, MI, USA, University of Georgia, Athens, GA, USA, and Moi University, Eldoret, Kenya).

Information in chapter 1 includes a brief overview of agricultural constraints in Kenya, a description of the Nzoia basin, research site descriptions, and the results of data collected on economic and land use activities within the study sites. Chapter 2 includes household level analyses of soil and water conservation activities and adopter constraints. Chapter 3 includes information on community-wide risks and assets. Chapter 4 summarizes information from the previous chapters in the context of livelihood vulnerability and soil and water management options. This thesis does not include in-depth analyses of economic conditions, government policies and cultural preferences for agricultural activities, all of which can add further understanding to livelihood vulnerability and land use practices.

CHAPTER I

BIOPHYSICAL AND SOCIAL CHARACTERISTICS OF KAPOLET AND MOIBEN SUBWATERSHEDS OF THE NZOIA RIVER, KENYA

INTRODUCTION

Land use activities within the Nzoia Basin, Kenya affect peoples' livelihoods throughout the watershed. Conditions in the upper watershed contribute to soil erosion, gully formation, flooding, and a loss of soil fertility in agricultural fields. Nutrients bound to soil particles contribute to the eutrophication of Lake Victoria as they move downstream. Management of the Lake Victoria watershed involves understanding the relationships between physical, biological, social and land use activities in addition to stakeholder' capabilities and motivations for participating in soil and water conservation (SWC) practices. Targeting appropriate areas within a watershed for conservation activities is critical to the success of the watershed plan. The ability of watershed stakeholders to adopt conservation activities depends on trust, knowledge, and the potential for SWC to sustain or improve their livelihood.

The predominant land use activity in the Nzoia basin is subsistence and cash crop agriculture. Farming is the main occupation and is the foundation to livelihood conditions for Kenyans in this region. The adoption of SWC practices reflects the diversity of rural households' needs and constraints to both internal and external influences (Place et al. 2001). Identifying and studying the reasons why people adopt SWC activities is important for the evolving process of policymaking, development of appropriate technologies, assessing the impacts of these technologies on user groups, and identifying marginalized people who may not be able to implement these activities (Place et al. 2001).

Historical Development of Land Use Management

Throughout the world, land tenure systems, class, gender and ethnicity play significant roles in access to and control of resources that sustain livelihoods (Thomas-Slayter and Rocheleau 1995). The current management of natural resources in Kenya originates from the colonial policies enforced during British colonial era of 1897-1960 (Odhiambo 1999). These policies supported colonial agriculture entrepreneurship by privatizing land and control over natural resources while simultaneously disrupting traditional tribal land use practices (Odhiambo 1999). The colonial government supported the claiming of land for large cash crop plantations in order to supply export markets and resulted in loss of forest and grazing land (Olson et al. 2004). In Kenya, the shift to private and state land ownership resulted in household livelihoods changing as access to resources once found within communal land (e.g., food, fodder, fuel, water) was privatized (Thomas-Slayter and Rocheleau 1995). The loss of shared access to common lands also cut ties in traditional social networks and affects household gender roles (Thomas-Slayter and Rocheleau 1995; Odhiambo 1999). An establishment of settlement schemes for displaced Kenyans was enacted by the colonial government and continued after independence in 1963 favoring tribes affiliated with the ruling governmental party (Olson et al. 2004). As a result, land became and continues to be fragmented with intensification of and dependence on rainfed crop production and the expansion of crop production to riparian areas for irrigation purposes (Olson et al. 2004). Semi-arid landscapes have been transformed as agricultural intensification results in a decrease in available grazing land due to agriculture expansion into marginal semi-arid landscapes while agro-pastoral tribes become sedentary (Olson et al. 2004).

With the change in land use towards privatization there is a growing disparity of wealth between communities, regions, ethnicities and gender. Access to resources, labor, and power are altered by privatization (Thomas-Slayter and Rocheleau 1995). Privatization has widened the gap between the rich and poor and stimulated the migration of men out of communities while leaving women as the head of the household (Thomas-Slayter and Rocheleau 1995). Land privatization in Kenya also enables owner eligibility for credit and cooperative memberships (Thomas-Slayter and Rocheleau 1995). Government and outside donors target regions of potentially high agricultural productivity for infrastructure intensification to support these agricultural systems, while also providing water systems, roads, and schools for the community (Thomas-Slayter and Rocheleau 1995). Agriculture in Western Kenya is the major industry providing cereal grains for domestic and export markets. Infrastructure around major towns supports intensified agricultural productivity; however, this infrastructure does not extend into rural communities.

Poverty Reduction Strategies

The Kenyan Government defines poverty as an "inadequacy of income and deprivation of basic needs and rights, and lack of access to productive assets as well as to social infrastructure and markets" (RoKMoFP 2001:13). Eighty percent of Kenya's population lives in rural settings and derive their livelihood from agriculture (Kilambya 2004). Of Kenya's population classified as impoverished, 53% live in rural settings (RoKMoFP 2001). Agriculture contributes to 26% of Kenya's gross domestic product, accounting for 80% of the country's employment and making up 60% of the national income (Kilambya 2004; RoKMoFP 2001).

Rural and agriculture development rank as top priorities for poverty reduction and intervention (RoKMoFP 2001). The goal of Kenya's national poverty reduction strategy is to reduce extreme poverty by 50% by the year 2015 through the inclusion of the poor in policy planning and the promotion of sustainable economic growth (RoKMoFP 2001). Reducing the number of people who live in poverty through development of the agricultural sector involves addressing issues of limited financial capital, access to credit, ineffective extension services, high farm input prices, low produce prices, inappropriate technologies, inadequate markets and infrastructure, unclear land policies, dependency on rainfed crops, insecurity, and increases in health risks (Kilambya 2004).

Although the Kenyan Government recognizes the need for development within the agricultural sector, funding for agriculture extension services have significantly declined within the past two decades to about 1.7% of the government's 2003-2004 annual budget (Kilambya 2004). Of the 1.7% budgeted for agriculture extension services, 43% was for research and 49% was for salaries, which left only 8% for operational extension services (Muyanga and Jayne 2006). Extension services are important to combat rural poverty, as they are the connection between research, education and implementation. The development of Kenya's agricultural extension system has included information on crop intensification, crop marketing, seed varieties, fertilizer choices, land use management strategies, and new technologies (Muyanga and Jayne 2006). Dissemination of this information has taken the form of extension demonstrations, model plots, training and visit sessions, farmer field schools, farmer cooperatives, individual consultations and group meetings organized by government ministry extension services, private companies, and non-governmental development

organizations (Muyanga and Jayne 2006). Restructuring of the current extension services requires a "system that is cost effective, responsive to farmer's needs, broad-based in service delivery, accountable and with in-built sustainability mechanisms," while expanding services beyond crop production advice to site specific rural development needs (Muyanga and Jayne 2006:5).

Watershed Scale

Natural resource management on a watershed scale is an attempt to identify and understand causal relationships between people, their actions, resources and ecological processes. This management approach represents a more holistic paradigm than traditional specific resource management techniques. Wangila and Swallow (2001:9) state there is value in working within a watershed framework because, "watershed hydrology is one of the great integrators of human activity, ecological processes and global environmental conditions." Kenya's participatory watershed management catchment policy, introduced in the 1980s, targeted soil erosion in the Lake Victoria basin and has shown considerable socio-economic benefits in areas targeted for extension activities (Hansen 2000). However, overall environmental conditions on the land and in the lake continue to decline justifying further research and understanding of unique livelihood strategies that may encourage SWC adoption (Hansen 2000).

Individual household characteristics offer some explanations for SWC adoption; yet identifying adoption capabilities on a larger scale can be useful for predicting adoption rates at a household level (Place et al. 2001). Analysis on a watershed scale may identify regional factors not identified in household level analysis (e.g., road conditions) that affect household decisions (Place et al. 2001). Place et al. (2001:9)

suggests that a possible understanding of the cluster pattern of SWC adoption can be explained by studying the "macro and meso-level issues related to input and output market access, financial systems, social capital, the political economy of public services delivery and project siting, etc...."

NZOIA BASIN CHARACTERISTICS

Lake Victoria (Figure 1) suffers from eutrophication and a resulting loss of endemic fish species. Eutrophication is caused by inputs from increased levels in phosphorous, nitrogen and sedimentation from basin land use practices. Significant land use changes in agriculture results in the loss of wetlands, forested areas, and shrub lands, which leads to the loss of vegetative cover and an increase in erosion (Hansen 2000). The loss of vegetative cover increases erosion, sedimentation, gully formation, and induces flood conditions. The Nzoia River Basin is the largest Kenyan basin draining into Lake Victoria.

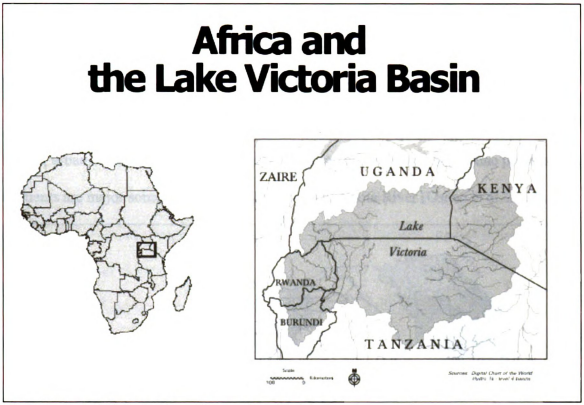

Figure 1. Lake Victoria Map Source: http://edcintl.cr.usgs.gov/images/lakevicmap.jpg

The Nzoia watershed spans the Western, Nyanza, and Rift Valley Provinces covering 12,984 km^2 (Figure 2). The basin can be divided into three sections to include lowlands, upper plateau region and highlands. Kakamega (population 86,500) and Webuye (population 45,100) are the major towns in the lowlands where land cover consists of irrigated and rain fed herbaceous crops, tree and shrub crops and permanently flooded lands (ILRI 2002). Eldoret (population 234,000) and Kitale (population 88,100) are large towns found in the upper plateau where land cover consists of plantation and natural forests, rain fed crops, shrub savannah, and permanently flooded areas (ILRI 2002). The highlands are characterized by Mt. Elgon and the Cherangani (Cherangany) Hills where the land cover is dominated by several stages of forest cover. Two rainy seasons support major maize and sugarcane agriculture industries along with subsistence

farming. This region provides 30% of Kenya's maize and sugar output (Osano et al. 2002). The headwaters of the Nzoia River are located in the montane rainforests of Mt. Elgon and the Cherangani Hills and flow through protected forest, agricultural, urban and industrial landscapes covering 252 km to Lake Victoria (Osano et al. 2002). Agriculture runoff, urban effluent, paper pulp mill, textile factories, coffee and sugarcane processing effluents are major sources of water pollution to the Nzoia River (Osano et al. 2002).

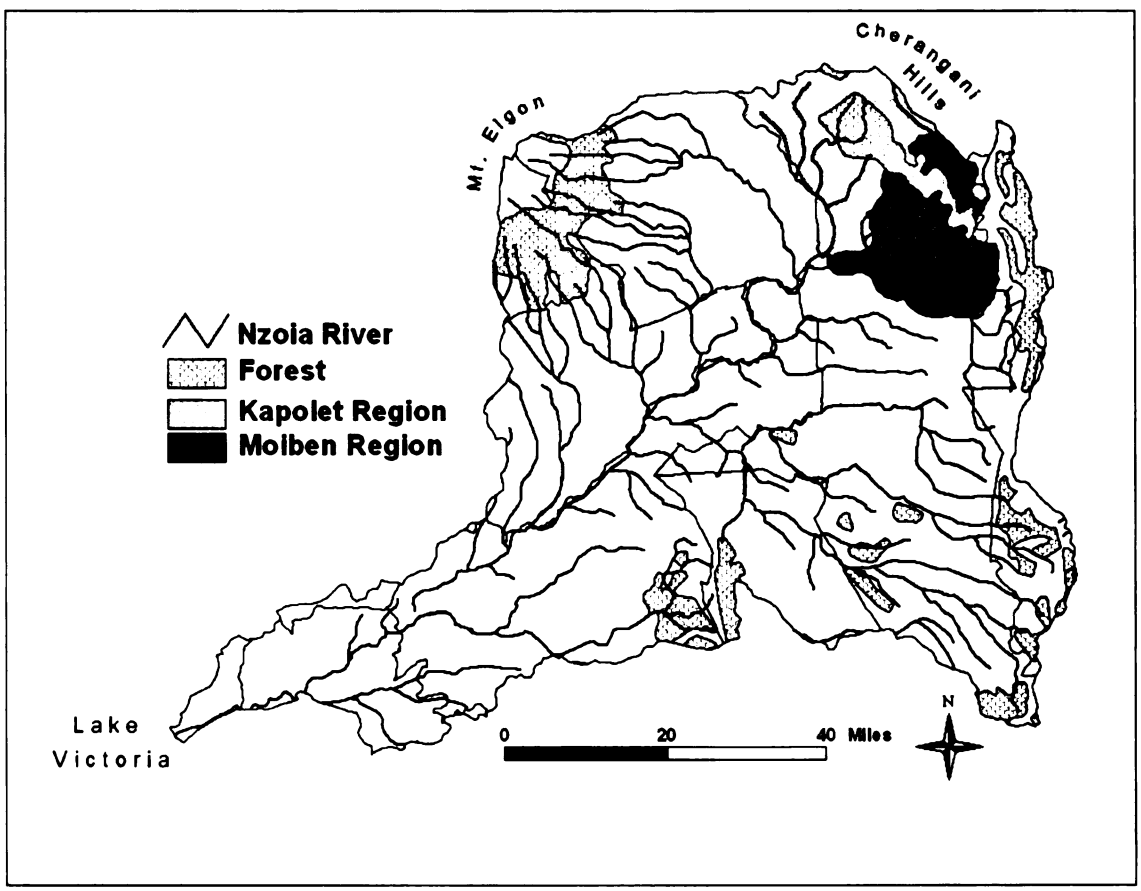

Figure 2. Nzoia Basin Map

SUBWATERSHED STUDY SITES

The Kapolet subwatershed and Moiben subwatershed were the study locations chosen by principal investigators of the larger project titled "Hydraulic, Water Quality and Social Assessment of the Nzoia Basin, Kenya Fishery" based on funding,

accessibility, time constraints, and previous research in the lower Nzoia basin. Specifically for this research, two study sites within these subwatersheds were chosen based on accessibility, presence of a Ministry of Agriculture extension officer and the contrasting history of SWC activities. However, the latter could not be validated.

Four villages in the upper reaches of the Nzoia basin were chosen as study sites representing two distinct tributaries to the Nzoia River shown in Figure 3. Headwaters from both Kapolet (Kabolet, Ainomaget, Upper Nzoia) River and Moiben River originate in native forest of the Cherangani Hills and then flow through remnant forest patches to cultivated areas and eventually combine to form the Nzoia River. Munyaka and Sengwere were two targeted villages in the Kapolet river watershed, which represented areas of intensive agriculture on steep slopes directly bordering the forest. Meibeki and Barsombe were two targeted locations in the Moiben river watershed that represented areas with intensive agriculture on gentler slopes further from the headwater forest.

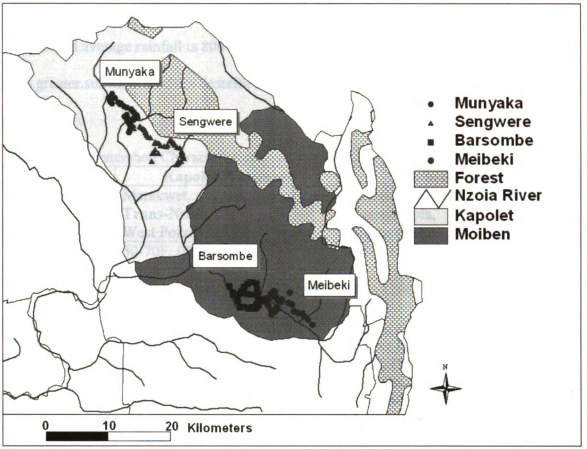

Figure 3. Kapolet and Moiben Study Site Map

The Kapolet River and Moiben River collectively form the Nzoia River originating in the Cherangani Hills. Each of these rivers represent a distinct agro-ecological zone based on topography and rainfall. The study sites along the Kapolet River are found in sub-humid and semi-humid area of the lower highlands of the Cherangani Hills where mean air temperatures range between 14-18C with average annual rainfall is 1200mm-1600mm (ILRI 2002). The villages in the Kapolet subwatershed are situated in hilly to mountainous terrain occupied by closed multistory forest cover or rain-fed shrub cropland (ILRI 2002). The Moiben region sites are characterized by a transitional semi-humid to semi-arid zone of the lower highlands in the Cherangani foothills (ILRI 2002). Euphorbia and acacia trees are common vegetation in

what is otherwise rain-fed herbaceous cropland. Mean air temperatures range between 15-18C and average rainfall is 800-1200mm per year (ILRI 2002). Characteristics of each greater subwatershed are described in Table 1, study site characteristics are in bold (ILRI 2002).

Table 1. Subwatershed Characteristics

	Kapolet Watershed	**Moiben Watershed**
Government Districts	Marakwet, **Trans-Nzoia,** West Pokot	Marakwet, Trans-Nzoia, **Uasin Gishu**
Average Temperature	50-70F, **(57-64F)**	36-75F, **(59-64F)**
Average Rainfall	1200-1600mm/yr **(47-63in/yr)**	800-1200mm/yr **(31-47in/yr)**
Agriculture-ecological Zones	Upper Highland (occasional night frost) (50-59F) -Humid -Sub-humid **Lower Highland**- (no frost), (59-65F) -Humid **-Sub-humid** **-Semi-humid** -Transitional Upper Midland (64-70F) -Semi-humid -Transitional	Tropical Alpine (36-50F) Upper Highland (occasional night frost) (50-59F) -Humid -Sub-humid **Lower Highland**- (no frost), (59-65F) -Humid -Sub-humid -Semi-humid **-Transitional** Upper Midland (64-70F) -Semi-humid -Transitional Lower Midland (70-75F) -Arid
Land use	**Agriculture** **-rainfed herbaceous crops** **-rainfed shrub crops** **Forest** -open trees **-closed trees** Woodlands Bush -thicket Plantation Wetlands	**Agriculture** **-rainfed herbaceous crops** Forest **Woodlands** **Bush** **-shrub savannah** Plantation

* Study site characteristics in bold

DATA COLLECTION

Data collection occurred from August 2005 to October 2005. Assisted by three local Kenyan research assistants, data were acquired through personal observation, key informant interviews (n=8), household questionnaires (n=172) and participatory rural appraisal activities (n=4). Assistants had prior university or development organization training in natural resource based participatory rural appraisal activities. One assistant, a recent graduate, was recommended by a professor who teaches participatory rural appraisal techniques from Egerton University and the two other assistants were former employees of Vi Agroforestry. They were specifically hired to help administer the household interviews and to facilitate community group discussions. Community meetings and household interviews were held in a mix of Kiswahili, Kalenjin and Luhya languages and notes were transcribed into English by the assistants. Initial contact with villagers was coordinated through the location chief (local government representative) and/or a Ministry of Agriculture (MoA) extension officer. In each study site, the representative MoA officer was asked for a combined list of approximately 25 names of people who he felt represented the following categories: poor, average class, wealthy, women headed households, and farms adjacent to a waterbody. This list provided a household from which each interview day started and was an attempt to capture a broad representation of people from different family groups, economic classes and villages within the greater site area. After the initial names were used to disperse the areas in which each assistant completed interviews, household selections were random, although influenced by accessibility and whether an adult household member was home and willing to participate. The "Guide to Field Methods for Comparative Site Analysis for

the Land Use Change, Impacts and Dynamics Project" prepared as part of the LUCID 2001 project of the International Livestock Research Institute was used to help develop household survey questions (Appendix A) (Maitima and Olson 2001).

Approximately two weeks were spent in each site. During the first week household interviews were completed while also publicizing the community meetings that were held the following week. Community data were collected using modified participatory rural appraisal methodology and included a local time-line of events in the past ten years, a resource sketch map, transect walks and risk identification and ranking by gender. A general community meeting to complete a time-line and resource sketch map was held on the first day of the second week and was open to the entire community. The following two days gender specific meetings were held to identify specific community risks, problems or concerns and to discuss the root causes and potential solutions to these risks.

I conducted key informant interviews with representatives of each study area (Appendix B). In the Kapolet region , interviews were held with the Vi Agroforestry extension officer and the location chief of the Munyaka and Sengwere areas, and with two MoA extension officers who each represented a study site (n=4). In the Moiben region, two interviews were held with local chief representatives for the Meibeki and Barsombe locations and two MoA extension representatives (n=4). Permission was acquired for all interviews and community meetings based on the oral consent script approved by Michigan State University's University Committee on Research Involving Human Subjects (Appendix C).

RESULTS

Household Characteristics

Data encompassing demographics, household characteristics, household agricultural practices, and opinions about local land use activities were collected during household interviews. The results from household questionnaires in each study location, Kapolet (n=91) and Moiben (n= 81) regions, are represented in Table 2.

Table 2 . Household Respondent Characteristics and Demographics

		Kapolet		Moiben	
Village Study Sites		Munyaka (n= 49) Sengwere (n=42)		Meibeki (n=36) Barsombe (n=45)	
Respondent Gender		# (n=91)	%	# (n=81)	%
	Male	60	65.9	48	59.3
	Female	31	34.1	33	40.7
Age		# (n=89)	%	# (n=81)	%
	20-29	7	7.9	10	12.3
	30-39	16	18.0	16	19.8
	40-49	23	25.8	22	27.2
	50-59	13	14.6	13	16.0
	60+	30	33.7	20	24.7
Occupation		# (n=91)	%	# (n=81)	%
	Farming	80	88.0	68	84
	Laborer	1	1.0	1	1.25
	Business	2	2.2	1	1.25
	Soldier	0	0	4	4.9
	Teacher	3	3.3	3	3.7
	Other	5	5.5	4	4.9
Education		# (n=90)	%	# (n=81)	%
	None	20	22.2	19	23.5
	Primary	46	51.1	29	35.8
	Secondary	21	23.3	23	28.4
	Post-secondary	3	3.3	9	11.1
	Adult education	0	0	1	1.2
Wealth Status		# (n=89)	%	# (n=81)	%
	Poor	34	38.2	22	27.2
	Average	45	50.6	39	48.1
	Wealthy	10	11.2	20	24.7
Household Head		# (n=91)	%	# (n=81)	%
	Male	67	73.6	65	80.2
	Female	24	26.4	16	19.8
# of Household Occupants		# (n=91)	%	# (n=81)	%
	1-3	17	18.6	10	12.3
	4-6	30	33	28	34.6
	7-9	22	24.2	29	35.8
	10+	22	24.2	14	17.3
Tribe Affiliations		# (n=89)	%	# (n=76)	%
	Keiyo	0	0	26	34.2
	Kikuyu	48	54	1	1.3
	Luhya	6	6.7	1	1.3
	Nandi	0	0	32	42.1
	Sengwer	31	34.8	0	0
	Other	4	4.5	16	21

Wealth Status

Wealth status is a demographic trait that encompasses and is influenced by other traits such as gender, education, and property title, acreage and livestock ownership. Defining wealth is a result of cultural importance of resources. National poverty identification studies indicated approximately 46% of the people in the Kapolet region and 49% in the Moiben region live in poverty (Ndeng'e et al. 2003). In each region household respondents specifically described characteristics of being poor, average or wealthy. The field assistants then used these indicators to appropriately categorize each of the household interviewees into a wealth class (Table 2). Education level, house structure, livestock numbers, and acreage size were the dominant descriptive categories people used to classify wealth levels. A collective summary of descriptions of wealth class characteristics are reported in Table 3.

Table 3. Wealth Indicators- Household Questionnaire Summary

	Kapolet	Moiben
POOR	often unemployed and have to borrow from others	live day by day as laborers, are malnourished and poorly dressed
Education	primary school	children do not go to school
House	grass thatched	grass thatched, poorly maintained
Livestock	no cows	no cows
Acreage	< 1 acre	< 2 acres of poorly utilized land
AVERAGE	may borrow from others but feel obligated to repay	well dressed for special occasions, nutritional needs are usually met, considered eager to try new practices that may improve their livelihoods, often attend community meetings
Education	finish primary school	children finish primary and may go to secondary school
House	semi-permanent	semi-permanent or permanent
Livestock	1-2 cows	< 10 cows
Acreage	2-5 acres	< 10 acres
WEALTHY	well developed farm plan, income generating investments	often own tractors or machinery, employee others, manage their resources well to ensure a profit, do not attend community meetings
Education	secondary school education, children go to boarding schools	well educated, children go to boarding schools and university
House	permanent	permanent house with furnishings
Livestock	10+ cows	20+ cows
Acreage	5+ acres	20+ acres

Agriculture Systems

Through personal observation, key informant interviews, and household questionnaires animal and crop agriculture emerged as the predominant land use activity in these regions. Maize was grown mainly for household consumption by almost all households; the remaining maize harvest was then sold to purchase inputs for the next year. After the maize is dried and harvested, the kernels are ground in a posho mill to create maize flour. This maize flour is cooked with water to make the staple foundation food, ugali, which is typically eaten at least once a day. The amount of acreage a family needs for subsistence maize crop depends on the ability of the land to produce.

According to farmers interviewed in the Kapolet region, one acre produced approximately 30 bags of maize, with the input of one bag of fertilizer per acre. Farmers in the Moiben area reported that one acre produced approximately 20 bags of maize with an input of 2 bags of fertilizer per acre. Approximately two bags of maize were needed per person to support yearly subsistence. In the Kapolet region 67% of respondents, indicated that they produced enough food to feed their families and 76.5% in Moiben.

Information collected through household questionnaires regarding the regions' agricultural systems are reported in Table 4. Results of household questionnaires indicated that the size of farms in Kapolet (x= 4.6 ac, median = 2.5 ac) are smaller than in Moiben (x= 15.3 ac, median = 8 ac). In the Kapolet area, one large (220 ac) land-holding farmer was excluded in these figures because his land was subdivided and managed independently by several sons. MoA officers in the Moiben region reported farms being larger (30-50 acres) than what was indicated by individuals (14% $\geq$ 30 acres). These results suggest that either several families cultivated on one larger farm or extension officers had the most contact with farms over 30 acres. The majority of the farmers in the Kapolet region did not have the title to the land they farmed, whereas in the Moiben region the majority of respondents had titles to their land (Kapolet = 46.2%, Moiben = 64.2%). Steep slopes in Kapolet forced farmers to use hand hoes (71.4%) as their cultivation tool, while gentle slopes in Moiben supported the use of tractors (96.2%). Both regions hired labor because maize is only harvested by hand.

Table 4. Agriculture Systems- Household Respondent Summary

		Kapolet			Moiben		
Agricultural System	main crops	maize/beans/vegetables			maize		
	total # acres farmed	380 (600)one outlier w/ 220 acres			1182		
	acre mean	4.6 (7.1)			15.3		
	acre median	2.5 (2.5)			8		
	acre mode	2.5 (2.5)			6		
	acre range	.25 – 31 (220)			.1 - 100		
		#	#/house	#/acre	#	#/house	#/acre
	# cows	140	1.5	.37 (.23)	1123	13.9	.95
	# goats	18	.2	.05 (.03)	599	7.4	.51
	# sheep	156	1.7	.41 (.26)	766	9.5	.65
	# donkeys	23	.25	.06 (.04)	60	.74	.05
	# poultry	730	8	1.9 (1.2)	1117	13.8	.95
Food Self Sufficiency	yes	67 %			76.5 %		
	no	33 %			23.5 %		
Land Title	yes	46.2 %			64.2 %		
	no	53.8 %			35.8 %		
Rent Land	yes	41.8 %			37 %		
	no	58.2 %			63 %		
Hire Labor	yes	44 %			54.3 %		
	no	56 %			45.7 %		
Cultivation Tools	hand hoe	71.4 %			3.8 %		
	ox plow	1.1 %			0		
	tractor	27.5 %			96.2 %		

Rainfall in the Kapolet region allowed continuous cultivation of agricultural crops. Maize was grown as the main food crop and often intercropped with beans and vegetables. Cash crop production included surplus maize, vegetables, fruit, agroforestry produce, tobacco, sugar cane, tea and coffee. Rainfall in the Moiben region limited the diversification of crops. Most farmers only produced maize, wheat, millet, or sorghum. Maize was grown for both household consumption and as a cash crop. Vegetables were grown along accessible waterways for household use and were supplemented by limited subsistence consumption of beans, fruit, and grains. Animals were also important to the regions' agricultural system. The Moiben area had a higher density of cows, goats and

sheep per acre than the Kapolet area, whereas Kapolet's density of poultry per acre doubled that of Moiben.

Environmental Conditions and Land Use Changes

In the Kapolet subwatershed, Munyaka and Sengwere both occur in mountainous terrain with reliable biannual rainfall as described by residents. Water is supplied to these communities by rain fed mountain springs and streams. However, water quality was poor because of erosion and poor sanitation facilities. The reliable rainfall stimulates a constant herbaceous ground cover, but the steep slopes on which residents cultivated are considered a major influence on erosion. Forty percent of household questionnaire respondents lived in mid-hill slope conditions, followed by 27% at the foothills, and 21% on the hilltop near the edge of Kapolet forest reserve. Environmental conditions for the Kapolet region are listed in Table 5.

Table 5. Environmental Conditions- Household Respondent Summary

		Kapolet	Moiben
Soil and water conditions		high soil fertility high erosion potential steep slopes reliable rainfall adequate water	good soil fertility high erosion potential gentle slopes unreliable rainfall limited water
		% (n=85)	% (n=77)
Topography	hilltop	21.2	5.2
	shoulder	7	1.3
	mid-hill	40	35.1
	foothill	27.1	26
	valley	4.7	5.2
	flat	0	27.2
Water Source*	river	8.8 %	87.7 %
	spring/stream	46.2 %	7.4 %
	rainwater	11 %	3.7 %
	well	6.6 %	3.7 %
Water Quality*	clean	27.5 %	49.4 %
	dirty	12.1 %	51.9 %
Prior land conditions*	forest/ bush/ uncultivated	72.5 %	69.1 %
	cultivated	13.2 %	38.3 %
	fertile	37.4 %	18.5 %
	infertile	9.9 %	1.2 %

* multiple responses, percents may not equal 100

Land use change information was collected through key informant interviews and a participatory rural appraisal time-line activity in each village. Notable changes in land conditions in the Kapolet region revolved around changing market demands, weather conditions and land allocation. The area known as Munyaka was primarily allocated during the 1960's to people of the Kikuyu tribe, who are traditional agriculturalists. At that time, the land was settled by several families and has since been subdivided into smaller family plots. Respondents (72.5%) indicated prior to their cultivation, their land was uncultivated forest or bush. The people of Munyaka noted a change in forest resources with an increase in usage of the forest for cattle grazing, charcoal production and timber sales. The increased use of forest resources corresponded to limited non-

forest resources, such as the increase in agricultural input cost or the decrease in agricultural produce prices.

Since 1997, members of the traditional hunter/gatherer Sengwer (Cherangany) tribe have been resettled onto their native lands in the area known as Sengwere (Lynch 2006). Previously, this area was converted from indigenous forest to cypress, pine and blue gum tree plantation. The area was protected as an official government forest and logged. The recent settlement of the Sengwer people caused a shift from the residual government forest to small 2.5-acre agricultural plots. Areas previously designated as water catchments protected from cultivation are now being cultivated because of land shortages for resettlement.

In the Moiben region, Meibeki and Barsombe are located in the Moiben River valley at the base of the Cherangani Hills. The semi-arid landscape conditions limit the growth of ground cover and result in deep gullies formed by scouring during heavy rains. As described by residents, torrential downpours during the rainy season often created flashflood-like conditions where water rushed off the land quickly, carrying off soil, crops and loose material. Significant erosion and gully formation along the dirt roads were observed. During the driest time of the year, many people and cattle walked over 10 km to the Moiben River for water, resulting in high traffic areas and subsequent erosion. The Moiben River served as the primary water source for 87.7% of the respondents with 51.9% believing the water was of poor quality (Table 5). A high sediment load was apparent in the Moiben River from personal observations, while residents stated that water quality was poor during the rainy season and good during the dry season. Water was transported from the river to homes with tractors and donkeys and

carried by individuals of families who could not afford other transport methods. Several residents described past drought conditions when people and animals became frantic in pursuit of water and where livestock died in the river bottom creating further concern for quality of the remaining water. Ironically, the headwaters of the Moiben river are in the Cherangani Hills; the same catchment which supplies the city of Eldoret with ample clean water. Water is piped from the Chebara dam over 70 km to Eldoret.

Land in the Moiben area was recognized by the British government for potential cereal crop production and thus large colonial plantations were formed. Many of the families that live in the Moiben region today once worked on the colonial farms or were considered squatters. Land redistribution, registration, and granting of individual titles to Kenyans began in the 1950's and continued post 1963 independence. Notable land use changes in the Moiben subwatershed resulted from the conversion of these large colonial farms into smaller subdivided plots predominately by the Keiyo and Nandi tribes, two sub-tribes of the Kalenjin group who are considered to be agro-pastoralists. Household respondents indicated a majority (69.1%) of the land was not cultivated prior to their settlement of it. An overall loss of vegetation was indicated by the lack of fuelwood and the use of maize stalks for fuel. Thirty-five percent of the household respondents lived on mid-hill slope conditions, while 27% lived on flat terrain and 26% lived at the foothills (Table 5).

Land Use and Agricultural Problems

In both regions, household questionnaire respondents answered an open-ended question about the causes of land use problems. Thirty-six percent responded that insufficient financial capital for investment in fertilizer, certified seeds, labor and SWC

practices contributes to restrictions on land use. Thirty-six percent responded that land mismanagement due to the lack of knowledge, and training and extension services were root causes of land use problems. The following reasons in descending order all had a frequency rate of less than 7% soil infertility and erosion, negligence, slope or size of fields, weather, land tenure, and poor cooperation amongst community members.

When specifically asked about agricultural problems or constraints, similar issues arose as with land use, but also included market availability, insecurity, pests and animal diseases, and the limited supply of resources. Table 6 lists the frequency and rank of the agricultural constraints depicted by household respondents in each region. In both the Kapolet and Moiben regions financial capital and market resources are the first and second ranked agricultural constraints, respectively.

Table 6. Agricultural Constraints and Solutions- Household Questionnaire Summary

		Kapolet		Moiben	
		%	rank	%	rank
Agricultural constraints*	education	27.5	3	23.5	4
	insecurity	2.2	10	1.2	8
	market	33.0	2	39.5	2
	money	68.1	1	61.7	1
	ownership	6.6	7	13.6	5
	pests/diseases	5.5	8	8.6	6
	resource limitations	15.4	4	7.4	7
	soil fertility / erosion	9.9	5	13.6	5
	topography / acreage	3.3	9	0	0
	weather (droughts & floods)	8.8	6	28.4	3
Solutions to agricultural constraints*		%	rank	%	rank
	alternative income	12.1	2	14.8	2
	change farm strategy / diversify	11	3	9.9	4
	community organization	3.3	7	1.2	8
	cope	60.4	1	54.3	1
	credit/borrow	1.1	8	9.9	4
	family labor	5.5	5	2.5	7
	fertilizer, certified seeds, pesticides	4.4	6	8.6	5
	hire labor	3.3	7	2.5	7
	lease land	3.3	7	4.9	6
	seek outside assistance	1.1	8	1.2	8
	SWC adoption	8.8	4	11.1	3

* multiple responses % may not equal 100

Overall strategies for addressing agricultural problems in descending frequency order included coping, seeking alternative income, diversifying farming strategies, adopting SWC methods, using fertilizer, buying certified seeds and pesticides, borrowing money, using family labor, leasing land, hiring labor, working with community based organizations, and seeking outside assistance. Specific ranked solution strategies for each region are listed in Table 6.

In both regions respondents indicated that coping was the most common strategy for dealing with agricultural problems (Kapolet = 60.4%, Moiben = 54.3%). Respondents that indicated coping was a solution explained a feeling of helplessness

because they had no control over factors that inhibit their agricultural production. Coping was explained by respondents as a "wait and see" process where they continue to use traditional methods because employing a new strategy was too risky. Other people had sought out alternative income sources and could afford agriculture input costs associated with purchasing fertilizer and certified seeds, and hiring tractors, land, labor and produce transportation. Diversification of farm production was also a method with increased use for combating agriculture constraints. Farmers with the ability to diversify reduced their risks of failure, marketing constraints and low prices for specific crops. Diversifying was viewed as a method to ensure that there was a subsistence or cash crop available if another crop failed. According to opinions expressed in household interviews, farms that lacked agricultural diversity were also associated with the uneducated and poor.

Agriculture Extension Services

One main difference I observed between the Kapolet and Moiben region in terms of access to resources was the representation and activity of local governmental resources. Kapolet was served by very knowledgeable and active MoA extension officers who contributed to the communities' asset base. However, the governmental representative, chief or assistant chief, was not perceived by residents to be a revered person because he failed to address the needs of the community. In Moiben, the opposite situation occurred. The chief and assistant chiefs were active and respected by community members, whereas the MoA extension officers were not well-integrated members of their respective communities. These observations were based on informal dialogue with community members, household respondent questionnaires and

participants' reactions to the presence of both the MoA officers and Chief representation at the community meetings.

SUMMARY STATEMENT

The Kapolet and Moiben regions represented two areas in which different agro-ecological zones influenced farming strategies. The commonalities in agricultural constraints and strategies and the differences in farming techniques within the regions reflected farmers' attempts to maximize agricultural production given their topographic, climatic and development conditions in their respective regions.

CHAPTER II

CURRENT SOIL AND WATER CONDITIONS AND CONSERVATION PRACTICES IN TWO SUBWATERSHEDS OF THE NZOIA RIVER, KENYA

ABSTRACT: Identification of current soil and water conditions and conservation practices is an initial step toward development of appropriate technologies for land use management plans. In Western Kenya, land use activities for two villages along the Kapolet River and two locations along the Moiben River typify maize production potential and its cultural significance. Research objectives include identification of the: 1) kinds of soil and water conservation (SWC) practices in use, 2) factors that influence the adoption of SWC practices, and 3) characteristics of those who adopt SWC practices. Data were acquired in each location through participatory rural appraisal activities (n=4), informant interviews (n= 8), household questionnaires (n=172), and personal observation. Household respondents indicated that 59% apply organic fertilizer, 56% plant grass strips, 29% build terraces, and 29% leave land fallow. Significant relationships existed between the use of SWC methods and region-specific household characteristics (e.g., wealth, number and type of livestock, acreage and land ownership, and perception of soil conditions). People who adopted SWC practices had an interest and knowledge of SWC purpose and implementation. Steep slope conditions and financial resources also influenced adoption of SWC practices. If implemented, specific SWC methods act to prevent erosion and subsequent loss of soil fertility. Identifying opportunities to increase farmer's capacity to adopt conservation practices will contribute to meeting the demands for high maize production from this region, while also improving local and regional soil and water quality.

INTRODUCTION

Soil and water conservation (SWC) adoption often reflects individuals' access to and use of resources. In Kenya, concerns with soil fertility and soil retention and water quality and availability have been documented with changing political regimes, shifting agricultural demands, and environmental degradation. SWC studies in Sub-Saharan Africa suggest that adoption is influenced by knowledge and perceptions of soil fertility and erosion, access to extension services, land security, education level, wealth status, gender, topographic conditions and the individuals' cost/benefit analysis of implementation (Bandre and Batta 1999; Bewket and Sterk 2002; Boyd et al. 2000; Hanson 2000; Kerr and Sanghi 1997; Ovuka 2000, A; Ovuka 2000, B; Place et al. 2003; Shepherd et al. 2000). Individual livelihood strategies determine whether farmers implement SWC practices and this is influenced by individuals' social, physical, and demographic position (Boyd et al. 2000). The difference in these variables and the interactions among them creates heterogeneous land use strategies and the available assets to promote SWC adoption (Place et al. 2001).

The poverty-environment cycle infers that as poverty increases environmental degradation increases. These conditions build off each other and escalate. Poverty can be defined as the amount of assets people have and utilize to maintain their livelihoods (Reardon and Vosti 1995). Reardon and Vosti (1995) make the distinction between welfare poverty and investment poverty to indicate that households, which meet their minimum nutritional consumption levels, may exceed welfare poverty conditions yet lack enough assets to invest in SWC practices and therefore meet the conditions of investment

poverty. Investment poverty tends to be site-specific depending on needs of the environmental problem and costs of investment solution (Reardon and Vosti 1995).

The "recognition that rural households have different reasons and incentives to engage in agricultural production as a part of their livelihood strategy naturally gives rise to greater attention to the heterogeneous needs of distinct rural subpopulations" (Place et al. 2001:5). These heterogeneous needs make it difficult to determine whether to focus SWC extension activities in areas that are most likely to adopt practices, in areas where there is higher erosion potential, or to disseminate as much technology as possible (Place et al. 2001). Incentives are low when the benefits of SWC adoption (e.g., off-site erosion control or in areas of insecure land tenure) are not received by the landowner investing in the practice (Kerr and Sanghi 1997). All the factors farmers consider when adopting SWC practices cannot be predicted; therefore, presenting a variety of options increases adoption rates as landowners can weigh the costs and benefits of each practice (Place et al. 2001).

Intensified agricultural production during the British colonial administration promoted land privatization with the subsequent loss of common land. With intensified crop production, SWC practices were required and often forcibly implemented (Ovuka 2000 B). After Kenya received its independence in 1963, the focus on SWC activities declined and many physical practices were destroyed because they were viewed as a result of the oppressive colonial regime (Ovuka 2000 B). In 1974, the UN Conference on the Human Environment declared soil degradation to be Kenya's major environmental problem and this facilitated the development of the Kenyan National Soil Conservation Project (Ovuka 2000 B). This project targeted soil erosion by helping farmers construct

terraces and cut-off drains on their land (Ovuka 2000 B). Participatory watershed management activities began in 1988 with the implementation of a "catchment approach" by the Kenyan Ministry of Agriculture and Rural Development's National Soil and Water Conservation Programme (Hansen 2000). This approach involved working with communities to identify problems and solutions to soil erosion (Hansen 2000). Extension officers taught farmers about SWC practices, but actual implementation was left up to the individual farmer (Ovuka 2000, B). Today, SWC education is often disseminated through Ministry of Agriculture extension services and other non-governmental development agencies. Kenya's most recent SWC strategy involves clarifying previous land use acts for the purpose of riparian buffer protection included in the 2002 Water Act.

Hansen (2000:6) identified several factors influencing the adoption of soil and water conservation in Western Kenya, including the "magnitude of the problem as perceived by the farmers, the farmers' knowledge/earlier exposure to SWC, land ownership, available human and natural resources, proximity to ethnic clashes, personality and the appropriateness/feasibility of the recommendations." Previous SWC practices encouraged through extension activities in Kenya included construction of terraces and hedgerows with native plants; planting native grasses, trees and shrubs; improved fallows; retaining crop residue after harvest; establishing a compost system for manure and crop residue; and confining large animals for manure collection (Aboud et al. 1996; Place et al. 2003).

OBJECTIVES

The Kapolet and Moiben regions represent two unique farming systems as described in chapter 1. Given the agriculture and land use activities in the two study

subwatersheds, the research objectives included further evaluation of the: 1) kinds of SWC practices used (e.g., soil quality and soil retention), 2) factors that influenced the adoption of SWC practices, and 3) characteristics of those individuals/groups that used SWC practices in the Kapolet and Moiben regions.

DATA COLLECTION AND ANALYSES

Data analyses included a review of quantitative and qualitative data collected through personal observations, household questionnaires (n=172) and key informant interviews (n=8) as describe in chapter 1. A collective summary of landscape conditions is described from household questionnaires representing the Kapolet and Moiben regions. Quantitative analyses included percentages and ranks of SWC use in each region. The influence of household characteristics and physical traits on the percent adoption of manure, terraces, grass strips and fallows was determined by chi-square test of independence and evaluated at α=0.05 level. All statistical data analyses were performed using SPSS version 12.0 (SPSS 2003). Cramer's V, a measure of association, was used to detect relationships between multiple categorical variables to include education levels and wealth status levels. Differences in sample means for acreage and livestock numbers were established through independent samples t-test and analysis of variance for multiple variables to determine if relationships existed between the dependent variable of SWC adoption and independent variables such as demographic and site descriptive characteristics. To understand SWC adoption benefits, constraints, and education resources, qualitative information was coded allowing for frequency and ranks of conditions across the study sites.

CURRENT SOIL AND WATER CONDITIONS AND PRACTICES

Household respondents considered their soil fertility to be good in the Kapolet region. However, there was considerable concern about the loss of fertility as erosion was becoming a more visible problem and crop yields have decreased. Medium soil fertility was reported by 74.7% of the respondents, only 3.3% reported to have poor soil fertility, and 22% said their fields had very fertile soils. Of those respondents, 62.6% said their soil fertility had decreased and 29.7% stated it had increased. Respondents' explanations for soil fertility changes listed in declining frequency order, included past land use activities (whether the land was forested, under cultivation or left fallow), continuous cultivation and field rotation, lack of SWC measures, organic and inorganic fertilizer use, slope conditions and soil type. Erosion was noted by 39.6% of the respondents as a problem on their land and of those respondents, lack of SWC use and topography were the leading causes for erosion. The majority (60.4%) of respondents attributed SWC usage to be the reason erosion was not a problem for them. Kapolet soil conditions are listed in Table 7.

Table 7. Regional Soil Conditions- Household Questionnaire Summary

		Kapolet	Moiben
Soil fertility	high	22 %	4.9 %
	medium	74.7 %	93.8 %
	low	3.3 %	1.2 %
Soil fertility trend	decrease	62.6 %	66.7 %
	same	5.5 %	11.1 %
	increase	29.7 %	21 %
Is Erosion a Problem? Why?	**Yes**	39.6 %	43.2 %
	no SWC use	35.9 %	45.2 %
	topography	25.6 %	26.2%
	top soil loss	23.1 %	11.9 %
	weather	12.8 %	11.9 %
	knowledge	2.6 %	4.8 %
	No	60.4 %	56.8 %
	SWC use	82.5 %	62 %
	topography	17.5%	36 %
	weather	0 %	2 %

In the Kapolet region, soil and water conservation practices in use according to the Ministry of Agriculture (MoA) extension officer and Vi Agroforestry (a non-governmental organization) extension personnel, included grass strips, terracing, erosion trenches, strip cropping, alley farming or agroforestry, road water diversion, trash lines (crop residues), non-tillage, fallow lands and the use of animal manure as fertilizer. Household questionnaire respondents indicated that 63.7% used grass strips, 51.6% used animal manure as fertilizer, 31.9% used terraces, and 22% used fallowing (Table 8). Native plant use, intercropping and composting were also important soil and water management activities indicated by household respondents.

Table 8. Soil and Water Management- Household Questionnaire Summary

		Kapolet (n=91)			Moiben (n=81)		
SW management activities		%			%		
	manure	51.6			66.7		
	grass strips	63.7			46.9		
	terraces	31.9			24.7		
	fallow	22.0			37.0		
	inorganic fertilizer	68.1			90.1		
SW decisions and management* increase + decrease -	% usage change	-	same	+	-	same	+
	manure	6.6	5.5	39.6	2.5	16.0	46.9
	grass strips	4.4	18.7	39.6	1.2	25.9	17.3
	terraces	1.1	12.1	19.8	0	9.9	14.8
	fallow	7.7	11.0	3.3	7.4	18.5	11.1
	inorganic fertilizer	19.8	12.1	36.3	13.6	27.2	49.4

In the Moiben region, medium soil fertility was reported by 93.8% of the respondents, whereas only 1.2% noted their soil fertility as poor and 4.9% said their fields had very fertile soils. Of those respondents, 66.7% said their soil fertility had decreased and 21% noted an increase. Erosion was considered a problem by 43.2% of the respondents. Erosion was mainly attributed to topography, lack of SWC practices on their land or adjacent land and road runoff. For the 56.8% of the respondents who did not believe erosion was a problem the use of SWC practices was attributed to erosion prevention. Moiben soil conditions are reported in Table 7.

Soil and water conservation practices in use as noted by the MoA extension officer, household questionnaires, and personal observations, included grass strips, erosion trenches, fallow lands, hedgerows with native plants, road water diversion, and reforestation attempts. Household questionnaire respondents indicated that 66.7% used animal manure as fertilizer, 46.9% used grass strips, 37% used fallowing, and 24.7% used terraces (Table 8). Native plant use, hedgerows, and drainage ditches were also important soil and water management activities indicated by household respondents in the Moiben region.

Chi-square test indicated there a difference in perceived soil fertility conditions between the two regions (x^2=11.6, p=0.003). Of the people in Kapolet region, 22% said they had very fertile soils, whereas only 4.9% of the people in the Moiben claimed to have very fertile soils (Table 7).

Inorganic Fertilizer Use

Inorganic fertilizer use was observed in each region and was usually associated with the use of hybrid seeds. A difference between the regions and the percentage of farmers using inorganic fertilizer was detected (x^2=12.75, p<0.001). Sixty-eight percent of the farmers in the Kapolet region used fertilizer and 90% of the farmers in Moiben region used fertilizer. Both physical and social factors influenced the difference in fertilizer use between the regions. Wealth status was an indicator of chemical fertilizer use (Cramer's V= 0.438, p=0.000), with at least an 89% use by people of average to wealthy status level, whereas only 54% of the poor farmers were able to use fertilizer. An association between education level and use of fertilizer was detected (Cramer's V=0.281, p=0.009). Fifty-nine percent of the people with no formal education used fertilizer. Eighty-one percent of the farmers with a primary education used fertilizer, 84% with secondary education used fertilizer and all of the farmers' interviewed that had specialized training (n=13) used fertilizer. Current soil conditions were associated with fertilizer input. A significant difference was detected between low, medium and high soil fertility conditions and percent use of fertilizer (Cramer's V= 0.240, p=0.007). Fifty-four percent of the people who farmed on very fertile soils used fertilizer. Fertilizer was used by 75% of the farmers with low soil quality and by 83% of the people who had medium soil fertility conditions. A difference also occurred between mean farm acreage size and

the use of fertilizers (t=-2.5, p=0.015). Farms larger than five acres had at least 94% usage of fertilizer compared to farms less than five acres in size which had 67% usage. Larger farms were typically owned by more affluent farmers capable of purchasing fertilizer. These large farms were also inherently dependent on chemical fertilizer for short-term soil fertility improvements because livestock husbandry practices did not enable organic manure to be collected and transported to large land holdings.

SWC ADOPTION INFLUENCING VARIABLES

Household questionnaire respondents indicated SWC adoption was influenced by access to information and outside assistance, land ownership, land size, limited financial and physical implementation resources, livestock numbers, negligence, perceptions of sustainability and/or effectiveness, and topography.

Regional Relationships

Data collected on household characteristics were found to have a significant relationship with the adoption of manure, terraces, grass strips and fallowing, across the regions. Household characteristics (Table 2) and the cultural indicators of wealth (Table 3) are described in chapter 1. The agricultural systems and physical conditions (Table 4) for each region are also described in chapter 1. Differences between livestock, acreage and title ownership among the regions accounted for some of the significant differences influencing SWC adoption.

Except for poultry, the Moiben region had a larger percentage of livestock ownership per acre and household than farmers did in the Kapolet region (Table 4). Analysis of variance indicated a difference occurred in mean cattle numbers between the villages (F=2.7, p=0.044). Farmers in the Moiben region had more livestock per

household than farmers in the Kapolet region. In Sengwere 59.5% of the respondents did not own cattle, compared to the highest percentage of non-ownership among the other study sites was 26.5% in Munyaka. Regional livestock numbers and associated significant differences between regions are described in Table 9.

Table 9. Regional Livestock Differences- Household Respondent Results

Livestock	Kapolet		Moiben		Independent samples t-test		
	#	#/house	#	#/house	t	df	sig.
cattle	140	1.5	1123	13.9	-2.1	170	0.036
goats/sheep	174	1.9	1365	16.9	-4.5	170	0.000
donkeys	23	.25	60	.74	-4.2	170	0.000
poultry	730	8	1117	13.8	-3.2	168	0.001

The average farm acreage size in Moiben was approximately 3.3 times the size of farms in the Kapolet region (Table 4). This difference in mean acreage size between the two regions was indicated by t-test values of t=-4.6, p=0.000.

A majority (64%) of farmers had a property title in the Moiben region, whereas less than half (46%) of the farmers in the Kapolet region had a title to their land (x^2=5.6, p=0.018). Land ownership in the Kapolet region was influenced by the recent resettlement of Sengwere as most people (93%) had yet to be given a title to the land they were settled on.

Topographic conditions differed between the two regions. The Kapolet farms were on steep mountainous terrain and the Moiben farms were on hilly terrain with less of a slope grade (Table 5). Even though respondents indicated certain SWC practices, (e.g., grass strips, terraces) were needed for farms on steep slopes; the topographic data collected during household interviews did not have a statistically significant relationship with SWC adoption. Chi-square values indicated no difference in farm slope (hilltop,

shoulder, mid-hill, foothill, valley, or flat) and SWC use (manure p=0.079, grass strips p=0.886, terraces p=0.536, fallows p=0.316).

Factors Contributing to Manure Use

A collective summary of favorable responses to the use of organic manure on cropland included increased soil fertility and crop yields, low cost, and general availability. Constraints noted by household questionnaire respondents included limited availability, possible weed seed content, scorching effect, and application labor. Factors that had influenced whether people had decreased or increased their usage included a change in livestock numbers and land size, and cost of inorganic fertilizer.

The use of manure as a fertilizer in Kapolet region was 51.6% and 66.7% in the Moiben region with an increase in overall usage of 39.6% and 46.9%, respectively (Table 8). The significant difference between the two regions (x^2=3.98, p=0.046) was further explained by chi-square values indicating a difference between manure use across the four study sites (x^2=17.9, p=0.000). The difference may be explained by the low use of manure in Sengwere; 31% of respondents used manure, whereas the other sites had at least 64% manure use. Sengwere represented the study site with the lowest number of livestock and smallest plot acreage size.

The number of farmers who had property titles was different between the regions (Table 4) and may explain the difference between people with and without property titles and their use of manure (x^2 =21.2, p=0.000). Of the people who had their property titles 75% of them applied manure to their fields, whereas 40% of the farmers without a title used manure. Owning land likely indicates a farmer's ability to also keep livestock, and may lead to the relationship between having their property title and manure use. Farmers

who owned their land may also have felt more value in reinvesting into their soil fertility with manure fertilizer.

In both regions, owning livestock was an attribute of wealth status. The ability to keep livestock meant that manure may be managed for composting and application. Measure of association analysis indicated a positive relationship between wealth status levels and manure use (Cramer's V= 0.329, p=0.000). Evaluation showed that once farmers reached an average wealth level they were likely to use manure; at least 70% of the average and wealthy farmers used manure on their crops and only 36% of poor farmers used manure. Wealthier people tended to have more livestock and therefore more manure to use.

In both regions, education was also an attribute of wealth status. A significant relationship between levels of education (no education, primary school, secondary school, post-secondary school, and adult education) and manure use was detected by chi-square values of $x^2 = 13.58$, p=0.009. Measure of association values (Cramer's V= 0.282, p=0.009) indicated as education increases the use of manure increases.

Factors Contributing to Grass Strips Use

Grass strips were planted across slopes and often used in combination with terraces. In the Kapolet region 63.7% of respondents, used grass strips and 46.9% of Moiben region respondents used grass strips with an overall increase in adoption of 39.6% and 14.8%, respectively (Table 8). Grass strips are a traditional method of erosion control using various grass types depending on soil conditions and climate. The predominant grass grown on grass strips was napier (*Pennisetum purpureum*), which helps control runoff, prevents erosion, increases water soil percolation and provides

fodder. Notable disadvantages of grass strips included labor and maintenance costs, occupation of tillable cropland, and the potential to become habitat for rodents and other crop destroying pests. A difference in grass strips usage and the percentage of people that viewed erosion as a problem was detected (x^2=4.3, p=0.039). Half of the people who did not use grass strips viewed erosion as a problem, whereas 34% of the people who used grass strips on their property thought erosion was a problem.

Chi-square analysis indicated a difference in grass strip adoption between Kapolet and Moiben regions. Grass strips were used by 63.7% of Kapolet respondents and only 46.9% of Moiben used grass strips (x^2=4.9, p=0.027). However, there was no difference between cow ownership and use of grass strips (x^2= 2.25, p=0.133). Yet, of the respondents who used grass strips, 75% owned cows and there was a significant difference detected between mean cow numbers between the regions. Therefore, the examination of cattle ownership and grass strip adoption in each region was necessary for further clarification of which farmers used grass strips.

When cattle were subdivided between native and crossbreeds a relationship was detected between crossbred cattle ownership and grass strip adoption (x^2= 5.14 p=0.024). Specifically, in the Kapolet region, a t-test analysis indicated there was a difference between the number of crossbred cattle and use of grass strips (t=-2, p=0.047), as 65% of the people who used grass strips owned cattle. Adoption rates increased as farmers' herd size increased but overall herd sizes were small in the Kapolet region and the highest adoption rates were with farmers who had 1-2 cows. Crossbred cows were utilized specifically for increasing dairy production. Grass strip adoption in Kapolet may be a result of steeper topography and/or grass strips used as a source for fodder for dairy

cattle. Several respondents indicated that they specifically plant and manage their grass strips for livestock feed because grazing land was limited. Other respondents indicated their grass strips were cut and fed to their neighbors' cows if they did not use the fodder themselves.

Further analysis of grass strip adoption in the Kapolet region showed a difference between wealth levels of poor, average and wealthy and the use of grass strips (Cramer's V= 0.281, p=0.029). Grass strip usage increased when an average wealth level was reached; at least 73% of respondents in the Kapolet region with an average wealth level used grass strips.

Factors Contributing to Terrace Use

Terraces were used by 31.9% of the Kapolet region respondents with an increase in adoption by 19.8% (Table 8). In Moiben, many terraces were installed during colonial times and have been maintained or ploughed under by new property owners. At the time of data collection, use of terraces was 24.7% with a 14.8% adoption increase by households in Moiben region (Table 8). Terraces were used specifically to control runoff, prevent erosion and to promote water retention. The predominant disadvantages of terraces were land utilization, labor required to build them and overall investment in maintaining them.

Terraces were only used by 28.5% of all respondents. People with a property title were more likely to build terraces on their land (x^2=6, p=0.014). Of those people who used terraces, farmers who had a property title more than doubled those who did not have a title. Many people indicated that they did not have the title to their land because the

land was inherited from their father and the title remained in his name, or they were simply waiting for the lengthy process of receiving their titles from the government.

As described by interview respondents, one negative attribute associated with terracing and grass strip implementation was terraces and grass strips utilized land that could be otherwise farmed. A t-test indicated that those who adopted terraces possessed larger mean acreage than those who did not adopt terraces (t=-3.8, p=0.000). The average acreage size of non-terrace users was 7ac, while users had a mean acreage of 21.5ac. In contrast, grass strips were used by people with smaller average farm plots (9 ac) plots than non-users (13.6 ac), although no significant difference was detected by a t-test, in average acreage size and using grass strips (t=1.3, p=0.212).

Factors Contributing to Fallow Use

Leaving land fallow was an important soil fertility restoration action, however it was dependent on the ability of the farmer to allow some land to remain uncultivated. Twenty-two percent of the Kapolet respondents said they were able to maintain fallow land along with their crop producing land, with a 3.3% increase in land set aside as fallow (Table 8). The rotation of pasture/fallow land with crop land was also considered advantageous in the Moiben region for improvement of soil fertility, with a 37% use of fallowing and an 11.1% increase in land set aside as fallow (Table 8). There was a difference detected by chi-square between Kapolet (22%) and Moiben (37%) regions in leaving land fallow (x^2=4.71, p=0.03). This was likely associated with farmers in the Moiben region having larger land acreage (Table 4), which would allow them to leave a portion of their land fallow while cultivating the remainder. However, no significant difference was detected between mean acreage size and adoption (t=0.308, p=0.759).

The use of fallow land for livestock pasture was the main reason fallowing was favorable as this also allowed for the opportunity to restore soil fertility. Others felt that leaving land fallow was wasteful and had an overall low productivity.

The use of SWC practices was the main reason people believed erosion was not a problem for them and where erosion did occur the lack of SWC activities was also considered the main cause (Table 8). There was a difference between fallow use and perceived erosion conditions (x^2=6.8, p=0.009), as only 26% of those that practice fallowing thought erosion was a problem, whereas 48% of those that did not leave land fallow thought erosion was a problem.

SWC Summary

A summary of significant relationships between the targeted land use activities and household and physical variables are listed in Table 10. M/K indicates the area with the higher percentage of statistically significant difference.

Table 10. Significant SWC Variables- Household Respondent Results

	Region	Manure	Grass strips	Terraces	Fallow	Fertilizer
Region		M	K		M	x
Acreage	M			x		x
Cows	M	x	x (Kapolet)			
Education		x				x
Erosion			x		x	
Soil fertility	K		x			x
Title	M	x		x		x
Topography						x
Wealth Status		x				x

M=Moiben, K= Kapolet, x= significant relationship at $p \leq 0.05$

Characteristics of SWC Adopters

Data collected through individual household interviews enabled the analysis of associations between SWC adoption and specific traits of individual farmers and/or their farming conditions. In all four study sites, personal interest and having knowledge of

SWC practices were the top two ranked characteristics of SWC users as described by household respondents (Table 11). Slope conditions lent to the need for SWC implementation and having financial resources for implementation were the next ranked traits of SWC adopters. Household respondents described characteristics of other people that did not adopt SWC practices as those people who lacked understanding and implementation knowledge, had no personal interest because they believed their land did not need SWC, and demonstrated negligence (those capable with the knowledge and need, yet still not implementing SWC). Table 11 lists the characteristics of people who are either adopters or non-adopters.

Table 11. SWC Adopter Characteristics- Household Questionnaire Summary

	SWC Users %	SWC Non-Users %
personal interest	36.1	13.9
knowledge	33.8	43.6
negligence	0	12.1
land ownership	0.7	3.6
land size	2.2	7.3
topography	13.2	6.1
financial	10.3	6.1
physical constraints	2.2	1.2
cooperation between land users	0	1.2
maintains previous SWC	1.5	4.8

SWC Education Sources

The adoption of SWC methods also depended on where people learned about these activities. People sought information from people they trusted, from those with whom they had proven past relationships, and from those whom have demonstrated success. Sources for learning about SWC in both regions included MoA extension trainings, information acquired in primary and secondary schools, farmer training schools, information from friends, family, and neighbors, repeated methods used on

colonial farms and self-taught trial and error. SWC education source frequencies, ranks, and extension services for each region are listed in Table 12.

Table 12. SWC Education Sources- Household & Key Informant Interview Results

		Kapolet		Moiben	
SWC education sources*		%	rank	%	rank
	friends, family, neighbors	25.3	2	45.7	1
	extension	37.4	1	24.7	3
	school	9.9	4	25.9	2
	self-taught	11	3	18.5	4
	copy previous SWC method	8.8	5	3.7	6
	farmer training schools	1.1	6	9.9	5
SWC extension services		MoA extension & Vi Agroforestry/LIFE -community education -organic farming -marketing cooperatives -money management groups -agroforestry -fertilizer/seed recommendations -SWC demonstrations		MoA extension -individual farm consultations -fertilizer/seed recommendations	

* multiple responses, percentages may not equal 100

The Kapolet region was represented by two very active and educated MoA extension officers, who were visibly working with farmers, coordinating meetings, enabling farmers to go to training sessions and promoting SWC activities. These officers worked to educate the community on methods for improving agricultural activities (e.g., forming community based support groups, SWC demonstrations, and marketing of produce). Extension officers with the Swedish based development organization, Vi Agroforestry, also worked with these communities on natural resource management and sustainable livelihood strategies. These extension officers often coordinated trainings and programs together to maximize community outreach and participation. Emphasis in

these communities focused on general natural resource sensitization for conservation. Weekly education classes presented topics requested by the community members and have included catchment protection groups, cooperative formation, agroforestry, organic farming, composting, maintaining fallow land along streams, terracing, and growing napier grass for both fodder and erosion control. Respondents indicated their information gained from both MoA extension and Vi Agroforestry extension agents represented 37.4% of their SWC education and 25.3% of their SWC information came from friends, family and neighbors (Table 12).

The Moiben region was also represented by MoA extension officers and had received assistance from World Vision (an aid organization) for health, education, and water development. SWC practices in this region tended to be a result from those implemented during colonial settlement. Many farmers maintained grass strips or terraces that existed prior to their settlement. Extension services in this region were on an individual basis versus community-wide SWC education classes. In these cases, the extension officer helped individual farmers demarcate areas that would benefit from SWC activities. MoA personnel also supported reforestation activities and youth nursery projects. MoA personnel expressed difficulty in having responsibility for such large areas and in assisting farmers with quite different farming strategies. Both MoA officers and household interviewees noted that wealthier and more educated farmers did not attend community meetings because these farmers had the knowledge and financial capital to make farming decisions independently. In the Moiben region, learning from friends, family and neighbors represented 45.7% of the SWC information disseminated,

followed by a 25.9% that learned of SWC information in primary and secondary schools, and 24.7% from extension agents (Table 12).

DISCUSSION

Studies in Sub-Saharan Africa have examined land use activities and the influences of SWC adoption in regards to changes in political regimes, demographics, agricultural systems, and land degradation conditions to conclude that farming strategies often reflect individuals' access to and use of these resources. The variables that enable or constrain SWC adoption are often a result of circumstances that individuals have little control. These variables include individuals' social, physical, and demographic position in addition to political and community allegiances (Boyd et al. 2000). The relationship between these variables and their influence creates heterogeneity in the land use strategies of rural communities (Place et al. 2001). Dominant soil and water activities in the Kapolet and Moiben study subwatersheds included use of organic and inorganic fertilizer, grass strips, terraces, and fallowing.

The conditions that influenced SWC adoption in the Kapolet and Moiben regions corresponded to assessments previously conducted in Western Kenya (Hanson 2000; Place et al. 2003; Shepherd et al. 2000), Burkina Faso (Bandre and Batta 1999), Ethiopia (Bewket and Sterk 2002) Tanzania and Uganda (Boyd et al. 2000). The principal variables in this study that acted independently or in combination to influence SWC adoption included, personal interest, access to information, wealth variables (e.g.,livestock, land security), slope conditions, and perceptions and/or effectiveness of the practice.

Information Access

Access to information was a major influence of SWC adoption in the Kapolet and Moiben study sites (Table 11). Participants stated that land mismanagement was caused from the lack of knowledge, training and extension services. Limited SWC knowledge was a common determinant across sub-Saharan Africa, (i.e., Tanzania, Uganda, and Burkina Faso) (Boyd et al. 2000; Bandre and Batta 1999). Previous studies in the Nyando basin in Western Kenya found that farmers received information regarding specific SWC methods from different sources including extension personnel, friends and other farmers (Shepherd et al. 2000). Respondents in the Kapolet region indicated their main source of SWC information was from natural resource extension services, whereas in Moiben information was obtained from family, friends and neighbors (Table 12). The differences between the regions may be reflections of the social structure within the communities and the activity of MoA extension personnel.

Boyd et al. (2000) found participants with a primary level education were the most likely to invest in SWC practices. This indicated that some education was necessary, but those with higher levels of education may have had alternative livelihood strategies that made them less dependent on agricultural activities. In the rural subsistence agricultural communities', of both the Kapolet and Moiben regions, access to schooling was limited by availability, distance and school fees. High illiteracy rates were observed in both the Kapolet and Moiben regions and were likely the result of limited access to education resources (Table 2). Results for the Kapolet and Moiben regions indicate there was only a positive relationship with advancing education and fertilizer use (both organic and inorganic) (Table 10). In contrast, Bewket and Sterk (2002) detected

no significant relationship between adoption of SWC practices and respondents' education level.

Land Assets

Investment in SWC practices is often linked with farmers who have secure land tenure. Land ownership reflected relationships with manure application and terrace implementation in the Kapolet and Moiben regions. This may reflect the status of the farmer within the region in regards to both wealth (e.g., livestock numbers, education and farm size) and recent provisioning of the land (e.g., inheritance or resettlement). Both manure fertilizer application and terracing represent long-term SWC investments because the soil and water quality returns from these strategies are delayed, and, therefore having a property title is often necessary for security in these SWC investments. New farmers and recent immigrants found land security was a concern and this influenced their adoption of SWC in Tanzania study sites (Boyd et al. 2000). General SWC adoption and land security did not develop as a significant relationship in an Ethiopian case study (Bewket and Sterk 2002). Hansen (2000) reported that low adoption rates in Western Kenya were influenced by the availability of free grazing land and insecure land tenure. Land tenure insecurity had a direct effect on SWC adoption as areas considered common reflected lower adoption rates, whereas privatized land allowed farmers to invest. Areas of high adoption rates were found to be cash crop operations that continued with SWC practices enforced by colonization policies, whereas subsistence farmers had abandoned the enforced practices post-independence (Hansen 2000).

Changes in agricultural systems have reduced the size of individual farm holdings and the amount of available fallow land (Ovuka 2000, B). As described by household

respondents, leaving land fallow once allowed the soil to regain its fertility. The trend towards smaller farm plots reduced the amount of land left fallow and left farmers with the need to implement other soil fertility management strategies. Farmers in Kenya's Murang'a District indicated their land was unproductive without the use of inorganic fertilizer because of limited rotation of fallow land (Ovuka 2000, B). These farms were also found to be too small to support a family and forced them to seek alternative income which led to a reduction in farm labor and inability to maintain SWC practices (Ovuka 2000, B). No significant relationship was found between farm acreage and fallowing in the Kapolet and Moiben region. This may be explained by the overall low adoption of fallowing, the limited availability of free grazing land and the subsistence agricultural system where limited land is continually cultivated.

A case study in Tanzania revealed that farm size had a positive influence on the adoption of SWC practices (Boyd et al. 2000) and a case study in Western Kenya found a significant positive relationship between terrace use and acreage size (Shepherd et al. 2000). The adoption of terraces was the only SWC practice that showed a positive relationship with acreage size in the Kapolet and Moiben regions. Many of the terraces in the Moiben region were built on colonial farms and have since been ploughed under because of the subdivision of larger farms, new property boundaries and maintenance requirements. Labor investment requirements for terraces often mean that land used for subsistence or low profit crops were not terraced because these labor costs reduced the assets in which investment in SWC was possible (Ovuka 2000 A; Reardon and Vosti 1995). This change was also observed in the Kapolet and Moiben regions where farms were being subdivided into smaller plots. This creates situations where more families

need to subsist from smaller landholdings and subsequently makes SWC investment difficult.

Livestock

Shepherd et al. (2000) found that in the Nyando basin, there was a positive relationship between cattle numbers and grass strip adoption, as grass strips provided both fodder and acted as a SWC tool. A significant relationship was also found between cattle ownership and grass strips within the Kapolet and Moiben regions. However, a positive relationship between dairy cattle numbers and grass strips was only found within the Kapolet region. For these farmers, owning dairy cattle coincides with maintaining grass strips, each acting as an asset that influences the growth of the other.

Topography

Steep slopes are especially difficult to manage for agricultural use, since forest and bush cover once protected the slopes from erosion; intensive agriculture on steep slopes now require more SWC structures (Hansen 2000; Ovuka 2000, A). The Soil and Water Conservation Manual of Kenya recommends strip cropping and contour bunds on gentle slopes of 5-20%, land with slopes over 20% should be terraced and slopes over 56% should not be cultivated (Thomas 1997). Although, no significant relationships existed between farmers' topographic setting and adoption of SWC practices in the Kapolet and Moiben regions, one major reason respondents indicated for SWC adoption was because of slope conditions. A case study in the Nyando basin in Western Kenya linked high SWC adoption with areas of steep slope conditions (Hansen 2000). Respondents in the Kapolet and Moiben regions reflected similar attitudes as the Boyd et al. (2000) study where SWC implementation was considered important for farms in the

highlands but those on the gentle slopes in the lowlands did not perceive erosion to be a problem.

Perception of Land Conditions

One major characteristic of SWC adopters was their perception of current land conditions. Several studies found that a farmer's perception and understanding of land degradation determined whether SWC techniques were viewed as solutions that prevented and resolved soil fertility and erosion issues (Hansen 2000; Bandre and Batta 1999; Boyd et al. 2000). Perception of erosion in the Kapolet and Moiben regions contributed to the adoption of grass strips and fallows.

In the Kapolet and Moiben regions, people believed their use of SWC practices caused their soil fertility conditions to improve and/or their land management techniques prevented erosion (Table 7). In Tanzanian and Ugandan case studies, erosion was considered a problem by people who all implemented SWC practices (Boyd et al. 2000). SWC adoption also occurred within the group of people who thought erosion was not a problem, and may indicate that they felt SWC adoption prevented erosion problems (Boyd et al. 2000). In contrast, Bewket and Sterk (2002) found awareness of declining soil and water conditions did not influence adoption of SWC practices in Ethiopia.

In the Kapolet and Moiben regions, soil fertility was also linked to grass strip adoption where farmers with medium to high soil fertility conditions were more likely to use grass strips. This relationship may indicate that grass strip adoption was more prevalent in the Kapolet region where soil fertility conditions were better or that soil quality contributed to assets which enabled people to invest in grass strips for further protection of soil fertility. In both regions, respondents' explanations for soil fertility

changes included past land use activities, continuous cultivation, field rotation, lack of SWC measures, organic and inorganic fertilizer use, topography, and soil type.

Land use problems also revolved around limited resource access, changes in weather conditions, and poor cooperation amongst community members (Table 6). Respondents indicated their frustration with managing their fields as water uncontrollably ran off their neighbor's field and caused erosion on their own fields. These conditions led some to suggest that SWC practices would only work if all land users on the slope implemented them. Changing weather, steep slopes and activity upslope were also considered by respondents to cause erosion in the Chemoga basin, Ethiopia (Bewket and Sterk 2002). Chemoga basin farmers noted an increasing trend in erosion and a decline in soil fertility; however, the relationship between land overuse and decline in soil fertility was not established. Conversely, a common answer for loss of soil fertility in the Kapolet and Moiben region was continuous cultivation.

Both manure and chemical fertilizer inputs are needed to supplement declining soil fertility caused by erosion and intensive agriculture (Ovuka 2000 B). In both Kapolet and Moiben, land use activities were focused on ensuring soil fertility to generate plentiful and profitable crops. Using organic and/or inorganic fertilizer was the most common strategy in use to manage soil fertility. Fertilizer application was perceived as the easiest and the most attainable solution to declining soil fertility levels. In a SWC study in Kenya's Nyeri District, this view was also noted by farmers who felt that increased soil fertility was due to the proper use of organic and inorganic fertilizer (Ovuka 2000 A). In Burkina Faso, experiences applying manure and previous results have encouraged farmers to use this as a soil fertility conservation measure (Bandre and

Batta 1999). Application of fertilizer reflects the ability of farmers to gain short-term cost-benefit returns, whereas SWC technologies that offer both on-farm and off-site benefits may not present short-term benefits (Kerr and Sanghi 1997).

SWC Adoption Summary

This study looked specifically at the adoption of organic and inorganic fertilizer, grass strips, terraces, and fallowing practices and their relationships to influencing variables (Table 10). Differences between percent use of manure, grass strips and fallows occurred between the regions, although no difference was detected for use of terraces. Manure was associated with indicators of wealth. Terraces were associated with land security. Grass strips were more likely used by people who were diversifying their farming strategy with dairy cows. The benefits and constraints of these SWC practices were site and activity specific, which influenced adoption rates as described by household respondents. Grass strips were associated with farmers who believed their soil fertility increased and erosion was controlled through their use. Fallowing was also associated with people who did not think erosion was a problem because they felt their land use practices prevented erosion.

The differences between regions and the types of SWC implemented reflected available assets and contributed to farm strategy heterogeneity. The inclusion of SWC in farm strategies was attributed to individual limitations (e.g., land, labor, financial capital) and personal interest given their assets, land conditions, and knowledge of SWC implementation and management. Outreach capabilities and the willingness of community participants to accept new information were unique to each region and therefore influenced the adoption of SWC practices. Both regions indicated SWC

knowledge was a limitation to adoption; however, each region had different sources for receiving this information.

SWC adoption rates reflected how interactions among the influencing variables influenced adoption in each region. Characteristics of wealth had the most influence on adoption, both directly and indirectly. Some practices were not directly linked to wealth status but were influenced by characteristics of wealth (e.g., education, title ownership, livestock ownership, acreage) (Table 3). SWC activities are long-term investments that require an initial investment of time, labor, and money. These requirements make asset deficient farmers less capable of adopting SWC because of the delayed benefit returns. Manure, grass strip and terrace use were all linked to at least one asset-attributing variable that increased SWC adoption rates (Table 10). Exceeding investment poverty levels by accumulating assets which enable SWC adoption (Reardon and Vosti 1995) is often site specific and this was demonstrated by the interrelationships of the variables contributing to grass strip adoption in the Kapolet region.

CONCLUSION

Management within these subwatersheds involves understanding how stakeholders' perceive SWC technologies and stakeholders' incentives to adopt them given the relationships between physical, biological, social and land use activities. Farmers in the Kapolet and Moiben region understood the causes of erosion and the ramifications of soil fertility loss; however, most farmers lacked the ability to change land use practices due to variables that out of their control. Individual farmers had little control over governmental policies that dictated processing land titles, where and how agricultural extension services were deployed, market conditions, and governmental

investments in physical infrastructure (e.g., schools, roads). Farmers also had little choice in the plot of land they worked, as they were often inherited, and farmed the land despite high slope gradient. Farmers in the Kapolet and Moiben regions had similar circumstances for adopting SWC practices, many of these overlapped with findings in other SWC adoption studies. The connections between influencing variables makes for a difficult challenge in terms of targeting one variable, versus another, as a major controller of SWC adoption.

Influencing variables that affect SWC adoption of one farmer and not another, suggests the need for providing a variety of SWC technology options (Place et al. 2001). Higher adoption rates of grass strips and manure use in the Kapolet and Moiben regions reflect the multiple purposes of successful SWC practices. Grass strip and manure use provide dual benefits and act as assets that promoted accumulation of other assets and may improve overall livelihood conditions. Grass strips represent an erosion control method with minimal investment in seed costs that could be used in all topographic conditions, while simultaneously providing feed for livestock by their maintenance. Manure use contributes to long-term soil fertility improvements by incorporating organic manure into the soil which reduces the need for chemical fertilizer whose nutrient value is likely to be lost with erosion and heavy rains. Widespread manure use is limited by supply and application labor. However, most households have livestock from which manure compost could be made and applied to household compound gardens.

Providing a range of SWC opportunities with visible short-term benefits for both small and large landholdings may increase adoption rates. The subsistence farming communities within the Kapolet and Moiben regions reflect a trend in decreasing farm

plot size. The smaller farming plots need SWC practices that are beneficial to a landholder that is likely to be less educated and less affluent than larger landholders. The development of appropriate SWC technologies that reach a greater percentage of stakeholders may show that SWC is not an activity reserved only for the wealthy landholders. Reaching a larger number of stakeholders with viable SWC adoptions may have a greater impact on overall soil and water conditions because land management schemes in these areas were based on small subsistence farms.

The influence of demographic and physical conditions on SWC adoption is likely to remain unchanged. A farmer's wealth status is a result of the interaction of multiple variables and may require intensive extension services to gradually increase wealth accumulating assets. Therefore, there is a need to encourage SWC adoption that takes into consideration the present wealth and physical circumstances of each farmer. Dissemination of SWC information must account for the method by which farmers receive information. In the Kapolet region, extension officers successfully disseminated information. However, in the Moiben region, information was more likely to be disseminated through friends and family members. Further evaluation of the most effective way to disseminate SWC information in each of these communities may help to develop land use management plans. Improved extension services that work within a community's cultural communication system may improve SWC adoption rates by providing knowledge about different types of SWC practices, their purposes, and the tools needed for implementation.

CHAPTER III

RISK AND ASSET ASSESSMENT IN TWO SUBWATERSHEDS OF THE NZOIA RIVER, KENYA

ABSTRACT: Assessing risks and assets aids in understanding how livelihood strategies reflect changes in vulnerability. Mitigating risks is dependent on people's ability to pool and accumulate assets on either an individual basis or community-wide level. In Western Kenya, livelihood strategies along the Kapolet River and Moiben River reflect the role of financial, human, natural, physical, and social capital. Research objectives include identification of: 1) risks and assets and 2) the strategies used to manage and enhance the capital resources in the Kapolet and Moiben regions. Data were acquired in each location through participatory rural appraisal activities (n=4), informant interviews (n= 8), household questionnaires (n=172), and personal observation. Participatory risk ranking activities identified health issues, communication infrastructure, insecurity, water, markets, unemployment, and leadership as major concerns. Notable identified assets included local natural resources, churches, police posts, governmental extension services or representatives, non-governmental organizations and community-based organizations. Involvement in community self-help groups, altering farming strategies, and seeking outside assistance were strategies people used to help reduce risks and strengthen assets. Assisting communities in identifying opportunities for risk reduction and asset enhancement may contribute to more effective land management and poverty alleviation strategies.

INTRODUCTION

Livelihood vulnerability is an emerging concept in the development sector and may assist in understanding livelihood management for mitigating risks and accumulating assets. At individual, household, or community scale, measuring livelihood vulnerability involves an assessment of actual and perceived risks and assets. "Livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living" (DFID 2001:1). Assessing human vulnerabilities involves social capital, livelihood resilience, social protection, self-protection, and well-being in order to identify resilience, resistance and exposure to risk (Cannon 2000; Few 2003). Risks include physical, biological, economic, and political variables that result in unfavorable livelihood conditions. Assets include the same variables as risks, but are viewed as favorable livelihood conditions. The International Livestock Research Institute (2004) is one development organization that identifies livelihood assets to include: financial, human, natural, physical, and social capital (Kristjanson et al. 2004). Financial capital consists of the availability of cash, credit, and savings (Kristjanson et al. 2004). Human capital consists of knowledge, skills, labor, and health (Kristjanson et al. 2004). Natural capital includes resources found in land, air, water, wildlife, forests, and other natural resources (Kristjanson et al. 2004). Physical capital incorporates infrastructure features such as housing, water source, energy and communication (Kristjanson et al. 2004). Social capital comprises memberships, networks, institutions and access to influential people (Kristjanson et al. 2004). Financial, human, natural, physical, and social capital combine with the biophysical assets of location to assist in the development of household and community strategies for addressing livelihood risks.

In Kenya, research has explored economic, human, natural, physical and social capital to understand the relationships between livelihood strategies and vulnerability. As research seeks to understand what determines peoples' land use strategies, the relationships between culture and the environment have emerged as key elements for understanding land use activities (Thomas-Slayter and Rocheleau 1994). Previous research relied on biophysical models for predicting land use activities (Thomas-Slayter and Rocheleau 1994). This livelihood approach to development research focuses on assets and household strategies, whereas vulnerability analysis emphasizes negative characteristics and focuses on risks (Cannon 2000; Few 2003). "The ways that people divide and share knowledge, access, use, and control in rural resource management reflects the social, political and economic context at the local and national level" (Thomas-Slayter and Rocheleau 1994:6). "These factors influence the character and condition of the physical landscape as well as the roles of men and women as resource users, owners, managers and caretakers" (Thomas-Slayter and Rocheleau 1994:6). Using the analysis of the relationship among gender, resources, and sustainable development there is now a focus on the resource users, their resiliency and flexibility to deal with risks (Thomas-Slayter and Rocheleau 1994).

The concept of resilience within vulnerability analysis originates from ecological research where it defines a system's ability to recover after a disturbance and the system's ability to function, tolerate or adapt to disturbances (Turner et al. 2003). Human vulnerability assessment also includes an assessment of a social system's resiliency to vulnerabilities in their ever-changing environments. Identifying people's ability to prepare for and recover from a disturbance, the extent of social networks and the choices

people have about their exposure to risks help determine resiliency which contribute to their overall livelihood vulnerability (Montz and Evans, 2001).

Social capital is viewed as an important asset enabling people to share information and is an inherent livelihood necessity for many cultures. Participation in formal and non-formal network activities by both men and women encourages cooperation, reciprocity, and exchange to increase an individuals and households' ability to access public and private resources and to enhance decision-making capabilities (Thomas-Slayter and Rocheleau 1995). Networks help determine individual and household strategies for survival, accumulation and mobility (Thomas-Slayter and Rocheleau 1995). More formalized networks take the form of organizations and associations through which people have means to negotiate with political systems (Thomas-Slayter and Rocheleau 1995). Through these support systems people are able to reduce their uncertainty and risks regarding environmental degradation, decline in resource productivity and loss of income (Thomas-Slayter and Rocheleau 1994).

The prevalence of HIV/AIDS and the subsequent increase in livelihood vulnerability is being felt in the agriculture sector in Kenya. HIV/AIDS and associated illnesses are examples of risks that draw upon households' assets making their lives more vulnerable to reduced agriculture production, nutritional deficits and poverty conditions. Gillespie (2006) identifies how HIV/AIDS risk contributes negatively to the cycle of livelihood vulnerability.

> "After HIV has entered a community, the type and severity of its impacts on assets and institutions is then governed by the *vulnerability* of the system. These impacts will in turn determine the responses that households and communities adopt to deal with this threat- responses that lead to certain outcomes (nutrition and food security being among them) that themselves condition future susceptibility and vulnerability." (Gillespie 2006:7).

HIV/AIDS often results in a loss of important agricultural sustaining livelihood assets including human capital (e.g., labor, knowledge), financial capital, livestock, and crop production (Jayne et al. 2005). Severe risks can increase socioeconomic and gender inequalities as poor households sell their assets (e.g., land, livestock, labor) to mitigate risks making them even more vulnerable to additional risks.

OBJECTIVE

This research assessed livelihood risks and assets to understand how personal and community strategies reflected changes in vulnerability. The objectives were to 1) identify the variables that depict livelihood vulnerability in terms of risks and assets and 2) understand the strategies people use to manage and/or enhance their resources in the Kapolet and Moiben regions. Of particular interest were possible differences in risks, assets, and livelihood strategies between gender, family and village.

METHODS

Data Collection

Participatory Rural Appraisal (PRA) methodology enables communities to identify their own strengths and weaknesses and has the capability to empower them to engage in activities to reduce their known risks. PRA risk analysis was found to detect within-group heterogeneity of both exposure and severity of risks by Smith et al. (2000). This method has also proven useful to identify underrepresented issues (Smith et al. 2000). Holloway and Lindsey (1996) found PRA assessment useful in analyzing community vulnerability to risk, which actively allows the community to identify their perceived risks and capacity to cope with or prevent risks.

PRA assessments were carried out in two village/locations within each subwatershed (Moiben and Kapolet Rivers) in the upper highlands of the Nzoia basin. Data were collected through personal observation, key informant interviews, and PRA events including: transect walks (n=8), problem rankings, resource ranking/mapping, and asset identification. Data on assets, resource limitations and livelihood strategies were also captured through household interviews (n=172), key informant interviews (n=8) and personal observations.

Community PRA activities spanned four days in each location. The initial day covered a time-line of significant events in the last ten years and sketching a resource map; these activities were open to all community members. Separate meetings for men and women took place over the next two days. These meetings were used to complete risk identification and ranking activities. The final day involved resource and land use activity identification through transect walks of the community. To promote broader participation locally influential people were identified by the research assistants and were given only a brief period to talk while encouraging other community members to speak. Demographic characteristics of the community meeting participants were unknown. During the gender-based community meetings, the participants as a group identified their risks. People were asked about their problems or issues of greatest concern to their livelihood, these risks were not asked in the context of agricultural production. Risks were assessed to determine the extent of each risk in terms of its affect on the entire community and then were ranked in descending order from most to least severe. During this process, ten individuals (note: only nine individuals were available in Munyaka's

women's group) were chosen by random selection to individually rank the severity of each listed risk/problem by how it affected them personally.

Data Analysis

PRA methodology allows researchers to gain information through active community participation, letting the community members express their assets, risks and vulnerabilities to certain circumstances. Risk and asset analysis incorporated with PRA techniques allowed people to prioritize their risks and assets. Founded on PRA methodology, risks were assessed through a series of risk identification and ranking activities as reported in Smith et al. (2000) and replicated by Quinn et al. (2003). Smith et al. (2000) created an index system for severity and incidence for each identified risk. The severity index assigned a value of 1 to severe risks and 2 to less severe risks etc. (Smith et al. 2000). To normalize the degree of risk severity, the rankings were converted to an index scale where 1 had the highest degree, two had the lowest degree, and all other degrees were integers between (Smith et al. 2000). To calculate incidence, an index was made by proportion of respondents who identified the risk factor as, 0-no one was affected and 1-everyone was affected. This proportional incidence measurement captured how widespread the issue was within the community (Smith et al. 2000). To combine these indexes the following formula was used for each identified risk $Sj=1+(r-1)/(n-1)$, where Sj was the severity index value for each risk, r was the rank, n was the total number of risks identified and j was each specific respondent (Smith et al. 2000). The means of each risk identified were used to calculate the sample severity index (Smith et al. 2000). The risk index was calculated using $Rj=Ij/Sj$, where Ij was the incidence index value per respondent (Quinn et al. 2003). This process of risk identification and

assigning weighted values for severity and incidence for each risk allowed risks to be more realistically weighted compared to regular ranking activities that occurred in the larger group activity.

Individual risk index values were also calculated for each person selected which used the risk index method of weighting risk incidence and rank. The means of the risk index values were then compared using independent samples Mann-Whitney test to detect for a significant difference at α=.05 level for gender, region and gender differences within each village. All statistical data analyses were performed using SPSS version 12.0 (SPSS 2003).

Qualitative data collected during household interviews added to the understanding of the identified risks. These were coded to obtain frequency percentages.

RESULTS

The numbers of participants at each meeting site are indicated in table 13.

Table 13. Participant Numbers

Location	Community Meeting	Men's Meeting	Women's Meeting
Munyaka	69	38	14
Sengwere	106	24	47
Meibeki	53	22	50
Barsombe	37	26	45

Risks

The process of weighing risk severity and incidence helped distinguish heterogeneity within a community, especially since individual concerns can be suppressed in a larger community meeting. The risks identified during community meetings by all study sites included: disease and health issues, insecurity and illegal activities, poor communication resources, insufficient markets, limited farming

knowledge and poor education (Table 14). Disease (malaria, upper respiratory tract infections and diarrheal infections) and waterborne illnesses were common health concerns along with the inability to access adequate health facilities. Insecurity and illegal activities were concerns for all locations although each site had unique concerns such as cattle theft, burglaries, logging, charcoal production and breweries. Poor communication infrastructure was a problem in each site regardless of remoteness. Roads remained impassible during the rainy season, which limited access to markets, medical facilities and sources of communication (e.g., telephones, bus stops, post offices). Concerns with markets included sales of produce to intermediary buyers and the impact of national and international economic conditions on produce prices. Poor education was also considered a problem in all of the sites because of the quality and quantity of the education opportunities available to the participants. Despite recent free primary education initiatives, the expenses associated with educational enrollment (i.e., uniforms, books, supplies, transportation) limited participation in this opportunity. People identified poor education, lack of technology development for site-specific agricultural needs and poor agriculture information dissemination as impediments to farming knowledge.

The sample risk index *Rj* mean values and their subsequent ranking for each village/location for problems that were present in at least two sites are listed in Table 14. The top ranked problem and community strategy for each location are described according to information collected during community meetings. However, risk index values were based on an integration of both community-level risks and individual-level rankings. It is important to note that risk index values and ranks did not correlate across

the locations. For example, both Sengwere and Meibeki identified health issues as the top ranked risk; however, their index values ranged from 0.72 to 0.84. This means that while health issues were similarly important, more residents in Meibeki ranked health issues as a concern than Sengwere as they both felt the issue was a problem for 100% of the population.

Table 14. Risk Identification- Community Meeting Summary

Identified Risks/Problems	Munyaka		Sengwere		Meibeki		Barsombe	
	Rj	rank	*Rj*	rank	*Rj*	rank	*Rj*	rank
Water Shortage	*0.00*	0	*0.00*	0	*0.78*	2	*0.81*	1
Health Issues	*0.59*	2	*0.72*	1	*0.84*	1	*0.39*	4
Poor Communication Infrastructure	*0.58*	3	*0.72*	1	*0.56*	4	*0.48*	2
Insecurity & Illegal activities	*0.88*	1	*0.69*	2	*0.29*	11	*0.20*	10
Unsafe Water	*0.48*	6	*0.55*	5	*0.36*	8	*0.00*	0
Market Constraints	*0.57*	4	*0.62*	3	*0.34*	9	*0.25*	7
Poor Education	*0.09*	13	*0.55*	5	*0.51*	5	*0.42*	3
Poor Leadership	*0.24*	10	*0.60*	4	*0.00*	0	*0.30*	6
School Shortage	*0.00*	0	*0.50*	7	*0.22*	13	*0.00*	0
Insufficient Farming Knowledge	*0.54*	5	*0.19*	10	*0.43*	7	*0.25*	7
Unemployment	*0.14*	12	*0.27*	9	*0.61*	3	*0.00*	0
Land Shortage	*0.00*	0	*0.52*	6	*0.22*	13	*0.24*	8
Soil Infertility & Erosion	*0.45*	7	*0.00*	0	*0.20*	14	*0.00*	0
Environmental Degradation	*0.26*	9	*0.30*	8	*0.23*	12	*0.00*	0
Financial Resources	*0.32*	8	*0.00*	0	*0.06*	16	*0.34*	5
Food Shortage	*0.00*	0	*0.07*	11	*0.44*	6	*0.15*	11
Weather Conditions	*0.19*	11	*0.00*	0	*0.30*	10	*0.12*	12
Energy Resources & Supply	*0.19*	11	*0.00*	0	*0.16*	15	*0.05*	13
Household Disputes	*0.00*	0	*0.04*	12	*0.03*	17	*0.21*	9

Rj values: *1.00* = high risk incidence & severity, *0.00*= low risk incidence & severity

Village/Location Risks

In Munyaka, the issue of largest concern for the community was insecurity. At the time of data collection, cattle theft by neighboring tribes was an immediate threat with ensuing violence, burglaries and deaths occurring. Just prior to data collection the government sent a police force into the area to collect weapons; and, throughout the data

collection period police patrolled the area as a cattle theft deterrent. Cattle thefts resulted in the reduction of farmers' cattle herds or caused some farmers to sell their cows to prevent losing a major source of wealth. Munyaka and Sengwere are both located on the edge of the Kapolet forest reserve where cattle theft occurs. The forest was not only used as a hideout for the cattle thieves but was also used for logging and charcoal production, which are all illegal activities. To address these issues the community had contacted government authorities to establish new police posts in the area. In Munyaka, where insecurity had the highest risk index and rank residents/respondents noted risk was higher for those who lived in closer proximity to the forest than those who lived nearer to the village center where security is higher.

Health issues and poor communication infrastructure comprised the highest risk rankings across all sites and were the top ranked risk in Sengwere. Malaria and waterborne diseases were common in Sengwere. Lack of medical facilities and limited sanitation facilities also contributed towards health risks. Along with common tropical diseases, the people of Sengwere indicated that unwanted pregnancies and the difficulties of transporting pregnant women to medical facilities were problems for their community. The mountainous topography made road passage and maintenance difficult. No public transportation vehicles passed through the upper regions of Sengwere, limiting access to medical facilities, communication, markets, and government representation. Attempts to address inadequate medical resources included contacting government and non-governmental organizations for assistance in building medical facilities, sensitization of the community to preventative actions, collection of funds to help build facilities, and general coping with traveling long distances to reach facilities.

In Meibeki, health issues were the largest problem according to community meeting participants. People in Meibeki suffered from common tropical diseases (i.e., malaria, upper respiratory tract infections, and diarrheal infections related to poor sanitation facilities and unsafe water sources). Although clinics and dispensaries were located in the village center, the facilities lacked water and electricity needed to refrigerate medicine. According to community participants, the use of local herbal medication was a common remedy for illnesses. Assistance from World Vision (an aid agency) provided limited disease prevention funding and education. Community members felt that health sensitization would encourage people to change their behavior in regards to sexual practices, mosquito net use, boiling water, better household hygiene.

In the Moiben area, water shortage provided a serious concern. In Barsombe, it was the issue of greatest concern to the community. During the dry season, people expended significant energy to obtain water and resulted in a reduction of time for other activities. Large numbers of cattle were often slaughtered in the dry period due to water and food shortages. Cattle were considered a significant wealth indicator and acted as financial capital. The water shortage and subsequent reduction in cattle numbers may alter social and financial networks within the community. Opportunities suggested by community participants to combat water issues (i.e., shortages and quality) included borehole drilling, building roof water catchments, pooling money to pipe in water, and implementing reforestation activities.

Regional Risk Trends

Figure 4 shows the categories of village risks where at least one village had an index value greater than or equal to 0.50 on a scale where 1.00 is the most severe. Using

a risk index value of 0.50 as the cutoff helps to illustrate trends between sites of incidence and severity. Sengwere had the highest number of highly ranked risks (n=9) that were considered to affect a larger percentage of the population between the four study sites. The higher number of identified risks above 0.50 in Sengwere may be a result of recent resettlement in Sengwere, resulting in lack of infrastructure that may reduce risks. The Moiben region study sites, Meibeki (n=5) and Barsombe (n=1), had fewer risks that affected a larger proportion of the population or risks that did not have high rankings.

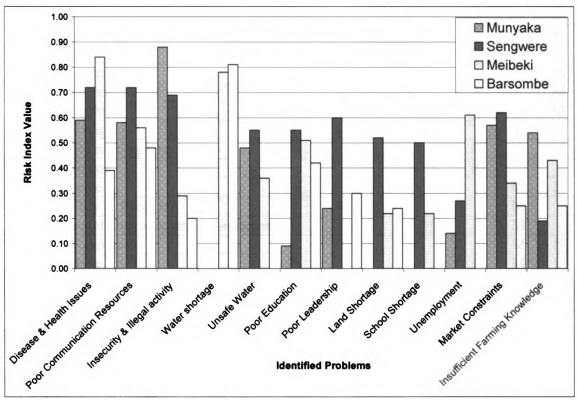

Figure 4. Risks Index Values ≥ 0.50

Munyaka and Sengwere in the Kapolet region represented areas with a greater number of risks with high severity and incidence rates. The Moiben region sites, Meibeki and Barsombe, collectively had a greater number of identified risks, though not as severe. Risks with statistically significant different mean values between the regions are reported in Table 15, a value of 1 indicates Kapolet had a greater mean index value and a value of

2 indicates Moiben had a greater mean index value as generated from independent samples' Mann-Whitney test and evaluated at $\alpha \leq 0.05$. Risks that were not significantly different among the regions included health issues, insufficient farming knowledge, unemployment, land shortage, limited energy resources and inadequate financial resources.

Table 15. Significant Risks $p < 0.05$

Identified Risks/Problems	Region	Sex	MK	SG	MB	BS
Water Shortage	2				M	
Health Issues						
Poor Communication Infrastructure	1	F				F
Insecurity & Illegal activities	1	F			F	F
Unsafe Water	1	F			F	
Market Constraints	1	M			M	M
Poor Education	2			F	F	M
Poor Leadership	1		F	M		M
School Shortage	1	F			F	
Insufficient Farming Knowledge		M		M		M
Unemployment			F	M		
Land Shortage		F		F	M	F
Soil Infertility & Erosion	1	M	M		M	
Environmental Degradation (deforestation)			F	F	M	
Financial Resources					M	F
Food Shortage	2			M	M	F
Weather Conditions (droughts & floods)	2		F			M
Energy Resources & Supply	1	M	M	M	M	M
Household Disputes	2	F		F	F	F

MK=Munyaka, SG= Sengwere, MB=Meibeki, BS=Barsombe
1 = Kapolet region (Munyaka and Sengwere villages)
2 = Moiben region (Meibeki and Barsombe locations)
M = Men, F = Women

Gendered Risks

Men's and women's meetings were held in each location to identify specific risks and assets of importance. Risks evaluated on a gender basis allowed risks to be weighted appropriately, as men and women had different problems or felt risks were more or less severe to them and their community. Individual risk index values (n=10 per village) were

calculated to allow for independent samples Mann-Whitney test analyses to compare risk index means by gender. Table 15 lists the risks where M indicates a statistically higher mean risk index value for men and F indicates a statistically higher mean risk index value for women.

Risks were uniquely generated in each meeting allowing some risks to be identified by only one gender. Several risks developed as being gender related problems as they had higher significant mean risk index values across all the study sites. Energy resources and supply was a risk only identified by men causing the statistical significance between genders. The concern about energy sources and supply may be a result of decline in forest resources and access to them. In the Kapolet region, the Kapolet forest reserve remained as an important source for charcoal production, which was an income generating albeit illegal activity for men. Charcoal production was observed during transect walks and household interviews. In the Moiben region, energy source concerns were more focused on fuel for tractors and electricity. Household disputes were only a concern with women as shown in three of the four study sites. Household disputes encompassed domestic violence, confrontation with neighbors, illegal home breweries and was associated with lack of employment opportunities. Women were often involved in home brewing of alcohol because they felt it was an important income generating activity. However, men were the main consumers of this alcohol and this often resulted in a reduction of their homestead financial resources and contributed to domestic violence. Agricultural production was predominately a concern with men, as reflected in the men having a statistically higher mean index values for market constraints, insufficient farming knowledge and concerns with soil fertility and erosion. Many of

these concerns were specifically focused on the production and marketing of maize as described in the community meetings. Men were typically responsible for securing financial resources to purchase farm inputs (e.g., certified seeds, fertilizer, labor and tractor hire).

Assets

Livelihood vulnerability consists of risks and assets. These assets are not only natural resource assets and basic needs but also consist of human, social, economic and cultural capital (Bebbington 1999). Bebbington (1999) described assets as capital that gives meaning to a person's life and gives them the capability to improve their quality of life. An attempt was made to generate a list of assets during the meetings with each gender, but this list did not go beyond basic needs. During the community meeting setting, it was difficult to get participants to talk about what comprised community strength, what resources were unique or particularly useful, and their strategies used for eliminating risks. Specific assets for each community were summarized from key informant interviews, personal observations, and household questionnaires.

Notable assets in Munyaka included church groups, merry-go-round groups, and extension services. An active Ministry of Agriculture extension officer, a Swedish non-governmental organization Vi Agroforestry extension person, church associations, and community-based organizations were actively developing workshops, securing funding, finding sponsors and providing trainings in Munyaka. The use of merry-go-round groups was suggested by key informant interviews and household respondents as an important local method of saving money and securing labor. Merry-go-rounds functioned as a group of people who pool a collected resource to give to one participating individual.

This collection and distribution is cycled through all the participants until all individuals have been compensated for their original investment. However, a few people suggested they did not trust other community members enough to participate in merry-go-rounds. Assets in Sengwere included fertile soils, community revitalization activities, and services provided by a Ministry of Agriculture extension officer. A unique asset found in Sengwere was the establishment of a cultural center that promoted preservation of tribal customs and provided education opportunities. In Sengwere, an active and knowledgeable Ministry of Agriculture officer provided community education classes ranging in topics from HIV/AIDS awareness, beekeeping, and soil and water conservation. The Ministry of Agriculture officer felt that the people of Sengwere were open and receptive to instruction on new methods to manage their resources that would potentially improve their livelihoods. Household respondents indicated that they did not participate in merry-go-round groups because they were new to the area and did not know their neighbors well enough or that they did not have capital for the original investment.

The people in Meibeki felt they lived in a welcoming and peaceful community. Crime was low because of local citizens that were vigilant and police monitoring. The assistant chief was active and held weekly court sessions that held people accountable for wrongdoings. Also, during data collection, the assistant chief held several meetings to assist with voter registration for the upcoming constitution referendum vote. Women's groups helped mobilize funds for its members and a youth group was participating in reforestation activities. The aid organization World Vision had funded education and general health sensitization.

One notable asset in Barsombe was the formation and registration of a women's group as a local community-based organization, which was eligible to apply for funding of local activities. Other women's groups, youth groups, and church activities were all indicated in household questionnaires as resources for community members. Out of the four study sites, Barsombe had the best access to markets on a tarmac road.

Resource Access and Control

Resource access is critical in achieving sustainable livelihoods, as access itself is a resource that may be limited by gender, political, economic, and social conditions (Bebbington 1999). Many risks were a result of limited access to resources, while many assets could be generated with access to resources. Table 16 lists the percentages of respondents that had access to physical and social resources in their community.

Table 16. Regional Resource Access- Household Questionnaire Results

		Kapolet %	Moiben %
Physical Resources	cattle dip	5.5	16
	machinery / posho mill	2.2	9.9
	market	51.6	46.9
	medical facility	37.4	55.6
	police post	2.2	0
	roads	30.8	58
	school	78	70.4
	water structure	4.4	2.5
Social Resources	church	68	54.3
	community based organization	45.1	22.2
	government extension (agriculture & health)	12.1	6.2
	non-governmental organization	5.5	12.3

Respondents indicated that many of their physical and social resources were limited by accessibility (Table 17). Travel distance to access resources was the greatest limitation in both regions. Resource supply and ownership ranked as the next biggest limitation. Access limitations because of age, time commitment, poor roads and

topography constituted the fourth ranked category. Financial restrictions, government policies and resource quality were also indicated as limitations to their natural, physical and social resources.

Table 17. Resource Access Limitations- Household Questionnaire Results

	Kapolet		Moiben	
	%	rank	%	rank
distance	70.3	1	76.5	1
financial	17.6	5	3.7	5
government policy	1.1	7	0	6
other	20.9	4	13.6	4
ownership	33	3	34.6	2
supply/quantity	41.8	2	29.6	3
quality	7.7	6	3.7	5

Table 18 lists the five asset categories and the frequency percentages of insufficient resources as indicated by respondents in each region. When questioned about what resources they lacked, household respondents in the Kapolet region indicated financial resources or the lack of credit opportunities to support agricultural investments where major concerns. However, limited financial resources were identified as a medium ranked (8^{th}) problem during the community meeting (Table 14). Natural resources (land and forest) and physical resources (schools, medical clinics, and roads) were also major resources that were deemed insufficient. Respondents also considered human and social resources to be inadequate in their community.

Respondents in the Moiben region indicated natural resources, mainly water, as the resource most limited to them (Table 18). Water shortage also received the highest rank of risks generated in the community meetings in the Moiben region (Table 14). Physical (roads, markets) and financial (credit) resources were also lacking to the people in Meibeki and Barsombe locations. Human (labor) resources were noted by a few respondents and no respondents indicated a lack of social resources in their community.

However, a few women explained the lack of cultural interaction with people outside their community as reason for their stagnant state of development.

Table 18. Resource Deficiency- Household Questionnaire Results

	Kapolet %	Moiben %
financial	48.4	23.5
human	5.5	4.9
natural	45.1	66.7
physical	38.5	32.1
social	2.2	0

Table 19 lists solutions suggested by respondents to improve assets thought to be insufficient. When household respondents were asked what they did about insufficient resources, the two most frequent responses from both regions were traveling long distances to reach resources and coping. Using alternative resources was the next most frequent strategy for dealing with unavailable resources. Examples of alternative resources included borrowing from neighbors and/or family when financial and/or credit institutions were not available and the use of seeds stored from previous seasons for planting instead of buying certified seeds. Other solutions included altering farming methods, seeking assistance from outside organizations for financial support, formation of community-based organizations, seeking additional education, and/or participating in illegal activities to compensate for lack of essential resources. These answers reflected livelihood strategies that were in use to best manage their existing vulnerabilities.

Table 19. Solutions to Insufficient Resources- Household Respondent Summary

	Kapolet		Moiben	
	%	rank	%	rank
alter farming strategy	18.7	3	8.6	5
community-based organization	2.2	6	0	8
cope	33	1	40.7	2
participate in illegal activity	1.1	7	1.2	7
seek education	3.3	5	2.5	6
seek outside funding	13.2	4	13.7	4
use alternative resource	18.7	3	19.6	3
travel far	30.7	2	43.2	1

DISCUSSION

This research attempts to understand the kinds of risks and assets and the effect vulnerability fluctuations have on livelihood strategies. Recent poverty reduction research has focused on understanding livelihood strategies that resulted from changing risks and assets. "Poverty relates itself to lack of basic material needs, it also signifies lack or deficiency of social, economic, cultural and human rights, which an individual household or community hold as important or vital for their existence, survival or well being" (RoKMoFP 2001:16). The livelihood approach focuses on how people use and manage their assets with the acknowledgement that differences occur between gender, tribal, and social groups (Bebbington 1999). People deficient in assets were likely limited in building resilience and preventing risk exposure. Risk prevention may require individuals to draw upon other assets making them even more vulnerable to remaining poor (Mukui 2005).

Risks and Assets

The identification of assets and risks along with needs and access to resources is one step in determining strategies that reduce individuals' livelihood vulnerabilities. Assets identified from household questionnaires included local natural resources,

churches, police posts, governmental extension services or representatives, non-governmental organizations, and community-based organizations (Table 16). The risks identified during community meetings by all study sites included: disease and health issues, insecurity and illegal activities, poor communication resources, insufficient markets, limited farming knowledge, and poor education (Table 14). Risks that did not have a significant mean risk index difference among the regions (health issues, insufficient farming knowledge, unemployment, land shortage, environmental degradation and limited financial resources) may indicate that these are problems occurring on a larger scale and are a result of changing resource use, resource user and political conditions nation-wide (Thomas-Slayter and Rocheleau 1994). One risk of growing concern to agricultural communities is HIV/AIDS. HIV/AIDS infection is highest in people between ages 15-45, who are the most productive work force members (RoKMoFP 2001). The World Health Organization (2004) reported a 6.7% HIV/AIDS infection rate in Kenya with over 30% HIV/AIDS infection in some urban areas, including western Kenya. Although HIV/AIDS did not emerge as an explicit risk in the study sites (note: HIV/AIDS is a sensitive subject not frequently discussed because of the associated negative stigma), participants were concerned about their vulnerability to disease. However, poor infrastructure and remoteness of study site communities limits peoples' movement to urban areas with higher infection rates and may actually help slow transmission of the virus to rural communities.

The risk index method developed by Smith et al. (2000) showed heterogeneity within and between their research sites in Northern Kenya and Southern Ethiopia and noted differences between gender and wealth status. Risks indicated by participants in

the Kapolet and Moiben region community meetings (human disease, insecurity, water shortage, food shortage, land shortage education limitations, and market constraints) were similar to those found by Smith et al. (2000). Heterogeneity occurred between the Kapolet and Moiben regions and between genders as unique risks and assets created varying vulnerability levels (Table 15). Gendered risks reflected men's concerns with agricultural production and women's concerns reflected household well-being and sustainability. A similar trend was also found within pastoral communities studied by Smith et al. (2000).

Social capital is an important asset; involvement in community groups provides security that increases individuals' resilience (Cannon 2000, Montz and Evans 2001). Both Kapolet and Moiben regions have social capital that increase individuals' resilience. Examples included women's participation in gardening groups which increased food security and groups for labor exchange. Church memberships assisted with funeral expenses, provided basic needs for destitute families, and contributed to household harmony by teaching family values.

It is difficult to label one region as having a greater livelihood vulnerability than another because vulnerability is subjective. Assessing both actual and perceived risks and assets is important because people's perception of vulnerability or resilience greatly affects their behavior and motivation. Risk identification and analysis results indicated that the Kapolet region had risks with a high risk severity and incidence and results in the Moiben indicated a greater number of identified risks but lower risk severity and incidence. Smith et al. (2000) indicated only two of 15 risks had a high risk incidence and a majority of risks had a low risk severity and incidence. The type, severity and

incidence of regional risks demonstrates heterogeneity within the watershed but also identifies risks that are likely to be watershed-wide poverty or development issues.

Risk Response

Responses to risk differ in effectiveness and sustainability and "are also context-specific, differing by community and by household in type and degree and they depend on the range of demographic, economic, and sociocultural factors and processes" (Gillespie 2006:7). The Kapolet and Moiben regions had unique problems which caused concern in each community and thus demanded unique solutions to each regions' problems. In Munyaka, participants expressed concerns with cattle theft and insecurity. The community's response to cattle theft and insecurity risk has involved increasing vigilance within the community and governmental police force. However, the political, socioeconomic, and physical conditions continue to place the Munyaka community at risk to cattle theft.

In Sengwere, the community indicated that poor leadership was a particularly important problem. The Sengwer recently received governmental recognition as a tribe and were resettled on their native lands that encompassed much of the area referred to as Sengwere. However, they have returned to settle land with people they did not know. This situation led to mistrust and unclear leadership. Attempts to reestablish a sense of community had begun with the development of a cultural center that teaches Sengwer traditional culture (i.e., language and dance). However, the Sengwer felt as though they still had no representation in the government to assist with their community's development.

In Meibeki, participants indicated unemployment conditions caused men to have too much idle time and resulted in alcoholism and illegal activities. Unemployment problems occurred in Meibeki due to seasonal labor requirements of the agriculturally based economy. Labor was in high demand during the maize harvest, but during the rest of the year, people had limited employment opportunities. Unemployment was considered a problem by both men and women in Meibeki and was their 3rd top ranked risk (Table 14). However, the consequences of unemployment were viewed differently by each gender. Women related the lack of employment opportunities as a cause of household disputes and domestic violence. This risk was only identified by women and therefore was not considered a community-wide threat. Home breweries were one source of alternative income generation in the Moiben region. Repercussions for drunken behavior outside the homestead were sought through a community court led by the local chief.

In Barsombe water shortage surfaced as the most severe and widespread risk (Table 14). No specific community response was identified to resolve their water shortage but rather individual responses used to cope with water shortage included early crop harvest, slaughtering of cattle and installment of roof water catchments. Solutions to meeting water transport problems included using tractors, donkeys and paying others for water transport.

Community Capacity

How a community responds to risk is influenced by the socioeconomic and biophysical context, the perceived severity of the risk among community members and the local collaborative capacity of the community members to solve problems (Flint and

Luloff 2005). Communities with a high degree of collaboration are more likely to act on perceived risks whereas communities with low levels of interactivity are less likely to respond to risks, even if those risks are severe and widespread (Flint and Luloff 2005). The community where one lives influences individuals' livelihood strategies with impacts on resource availability, educational sources, social networks and governmental representation.

Activities in Munyaka suggest the potential to increase community collaboration for addressing individual and community-wide risks. Insecurity was the top ranked risk in Munyaka and was being addressed through the utilization of available police enforcement. Due to the physical and socioeconomic context of cattle theft (i.e., cattle thieves were from a different tribe and different geographic locations, and loss of cattle resulted in loss of wealth), people in Munyaka were able to view cattle theft as a community-wide threat. Activities demonstrated by both men's and women's groups, merry-go-round groups, and active extension personnel have set positive examples for further collaboration that may assist in reducing the severity of other risks. The low number of gender-differentiated risks indicate that the majority of risks identified may be viewed as community-wide and non-gendered discriminatory risks.

High risk severity and incidence in Sengwere can be attributed to the resettlement process of forming a new community. Their limited access to resources is also a consequence of resettlement. Most resettled families were given 2.5-acre plots on steep slopes. Even though the land was considered very fertile, most families struggle to meet their subsistence needs. However, the community's ability to try to strengthen broken tribal customs with the formation of a community cultural center, identification of the

need for a strong community leader and high attendance at sensitization activities provide strong support for the notion that over time more collaborative activities may develop to assist in reducing risks.

In both Meibeki and Barsombe, water shortage was a major community-wide risk. Water shortage stimulates other identified risks such as health issues, food shortages and crop production limitations. Water shortage in the Moiben region is attributed to unpredictable weather conditions that can severely alter the water quality and quantity. Livelihood conditions are dependent on water supply as time and energy is spent on water collection. Water management is often an important unifying factor in a community (Cook et al. 2003). However, this research did not find a strong community mobilization focused on resolving their water issues. Some of the notable assets that assisted with the water shortage were donkeys and tractors; those people without transport often bought water. Water is a commodity which could justify why community mobilization had not centered on resolving the water shortage. Individual strategies reflected coping, helplessness and a dependency on external assistance to deal with the water shortage problem. With the assistance of a local aid agency establishment of a piped water system and storage tanks were being discussed. However, for individual households to participate a water pipe fee is required. This potentially continues the cycle of those people who are the most vulnerable to water shortage (lack of transport resources) to remain vulnerable because they likely lack sufficient financial capital for pipe fee investment.

CONCLUSION

The risks and assets identified in the Kapolet and Moiben regions most likely represent a small number of the actual risks and assets in each community, as individual vulnerability is based on how they manage their risks and assets to create resilience and reduce exposure. The risks that individuals and the community have not successfully addressed are likely the top ranked risks in each community. This could also justify why generating a list of assets was so difficult for community participants, as capital resources may seem important or unimportant depending on their current actual and perceived risks. Unique strategies are likely to have already alleviated past risks by drawing upon the assets that were available.

Few (2003:52) states, "it is increasingly accepted that people do not simply draw on their assets but possess sophisticated skills in managing them to cope with adversity and take advantage of opportunities." People in the Kapolet and Moiben region do take advantage of their assets in a manner that mitigates risks. On an individual level, management of specific assets contributes to increasing other assets, such as human, financial and social capital. Examples included farmers in the Kapolet region using available financial assets to diversify crop production to avoid risk of crop failure and market constraints, and women in the Moiben region committing time and labor to women's gardening groups to reduce risk of food insecurity and strengthen social networks. In the Kapolet region, on a community level, social assets are strengthening with the assistance of MoA extension and Vi Agroforestry services that encourage the formation of and participation in community groups to further their educational opportunities and improve their natural resource base. Within the Kapolet region, the

growing social networks allowed communities to overcome some resource deficiencies (poor communication and governmental representation) to seek assistance with their insecurity risks. Prior community group experiences may have enabled the community to adjust and activate existing social networks to increase community awareness and vigilance to the risk of cattle theft. In the Moiben region, community response to their largest risk, water shortage, was dependent on their association with aid agencies, governmental representatives and their subsequent ties with influential people.

The evolving process of building resilience, mitigating risks and accumulating assets makes identifying individual and community vulnerabilities difficult to manage. Improving current deficiencies in physical assets, such as communication infrastructure would begin to mitigate risks by improving access to health facilities, markets, credit institutions and government offices that are all limited in the study locations by distance. With increased access to these resources, people may employ new livelihood strategies to build resilience and accumulate assets to help alleviate risks. However, improving physical assets is highly dependent on political policies and the current political interest in the area. This then suggests that local management policies need to target risks that individuals and the community have successfully mitigated or build on assets that are attainable within the community.

CHAPTER IV

LIVELIHOOD VULNERABILITY INFLUENCES ON LAND USE MANAGEMENT STRATEGIES IN TWO SUBWATERSHEDS OF THE NZOIA RIVER

ABSTRACT: The intent of this research was to identify and understand livelihood strategies that determine adoption of soil and water conservation (SWC) along the Kapolet and Moiben rivers. This research used the sustainable livelihood framework as a guide to help identify relationships between livelihood vulnerabilities and SWC practices. If household or community level conditions lead to high livelihood vulnerability then SWC adoption will be limited. Results indicated heterogeneity across study sites regarding the vulnerability of households and communities to the impacts of available assets and potential risks on land use strategies. Livelihood vulnerability conditions in the Kapolet region reflected temporary resilience to their cattle theft risk by using social networks and altering farming strategies to avoid financial asset loss. Strategies in the Kapolet region included SWC techniques and agricultural intensification to reduce livelihood vulnerabilities. Livelihood vulnerability conditions in the Moiben region reflected resources being allocated to secure water and promote crop production, as water shortage was their greatest risk, which left few assets to buffer against other livelihood risks. Short-term agricultural investment strategies ensured crop production, while SWC methods were not viewed as cost effective strategies to protect their farming systems. These unique risks each influenced SWC adoption because the consequences of risks and the process of risk mitigation drew upon assets that could otherwise be used to help implement SWC practices. Linking land use practices with identified risks and associated community assets may help determine the best management strategies to mitigate risks and improve SWC adoption.

INTRODUCTION

It is widely acknowledged that environmental degradation results from the relationships between social, political, economic, physical, and biological conditions. Livelihood vulnerability analysis attempts to identify these relationships, while providing a method to understand the capability and/or motivation to implement SWC practices. To understand how livelihood vulnerability is applicable to natural resource management, concepts were drawn from risk, asset, livelihood, gender, resilience and poverty analysis literature.

This research used the sustainable livelihood framework to help evaluate and understand the connections between livelihood vulnerabilities and the adoption of SWC methods. "A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base." (DGID 2001:1). The sustainable livelihoods framework uses an analysis of financial, human, natural, physical, and social capital to understand how livelihood strategies are formed to build resilience, resistance and reduce exposure to further risks (Boyd et al. 2000; Turner et al. 2003). Moser (1998:3) makes the connection between vulnerability and assets stating, "the more assets people have, the less vulnerable they are, and the greater the erosion of people's assets, the greater their insecurity." Livelihood vulnerability conditions are reflected in strategies people employ and thus the choices they make to adopt SWC practices (Adato and Meinzen-Dick 2002).

Investment poverty reflects an accumulation of assets that brings a family above welfare poverty but not enough of the correct combination of assets to invest in SWC

practices (Reardon and Vosti 1995). Basing land use management on poverty analysis of welfare criteria may not reflect the actual ability of people to adopt SWC practices because their livelihood strategy may not reflect a level above investment poverty. Reardon and Vosti (1995:1502) state,

> "The movement of a household from the category of being poor in an asset (such as land) to being "investment poor" in general (not being able to make specific investments required for natural resource maintenance or enhancement), depends on the level of risk (from price and rainfall instability, or from insecurity of land tenure hence risk of appropriation of capital), on the nature of markets, and on whether these translate into lack of sufficient liquidity (to buy labor or materials for certain land improvements), and on the willingness to use the liquidity for the investment in question."

Adoption rates also reflect the short-term cost-benefit analysis by each landowner often seen with on-site implementation and benefits (Kerr and Sanghi 1997). Landowners that fall below their livelihood threshold are not able to adopt SWC practices or accumulate productive capital often resulting in relocating to marginalized land or leaving the agriculture industry (Muhia et al. 2001).

Western Kenya Agricultural Livelihood Conditions

Potential risks and assets available to households in the agriculture sector in Western Kenya contribute to poverty conditions. The lack of extension services, need for expensive farm inputs, insufficient credit facilities, poor market conditions, tenuous land tenure, deforestation, insufficient water management and the collapse of government agriculture institutes are among the issues contributing to poverty within the agriculture sector (RoKMoFP 2001). Agricultural intensification, livelihood diversification and migration are livelihood improvement strategies that are commonly pursued in combination or succession due to the lack of assets (Boyd et al. 2000; Scoones 1998).

Land use activities in Western Kenya reflect changes in livelihood strategies with an increased use of agriculture inputs, intensified crop production per acre, expanded cultivation areas, and increased environmental degradation (Conelly and Chaiken 2000). Changes in the types of produce marketed, non-farm income generating activities, diet quality, socioeconomic equality, and gender roles are also reflected in land use activities (Conelly and Chaiken 2000). These activities result from shifting resource access and balancing of livelihood risks and assets that are unique at individual and community wide scales.

The use of SWC is known to reduce the impacts of weather related risks, while improving soil water retention and improving soil fertility (Boyd et al. 2000). Benefits of SWC adoption to achieving sustainable livelihoods include higher crop yields and thus income generation, improved food security, and associated health benefits (Boyd et al. 2000). Social and human capital have improved in areas where SWC adoption involved collective action, which potentially improves individuals' overall well-being (Boyd et al. 2000). Proper natural resource use provides both on-site and off-site benefits easing environmental degradation (Boyd et al. 2000). Limited awareness, technical implementation knowledge, management conception, and potential benefits were all identified in western Kenya as reasons for low SWC adoption rates (Muyekho et al. 2003).

For many people throughout the world, the management of their natural resources is an innate process of weighing risks and assets. SWC adoption and livelihood vulnerability levels rest on the dynamics between risks and assets. The makeup of the vulnerability status indicates whether households or communities have the correct

combination of assets to mitigate risks. Household characteristics and regional risks and assets combine to indicate vulnerability conditions that dictate whether SWC efforts are feasible. Individual and community strategies used to mitigate vulnerability often have impacts on local land use activities and cumulatively affect the greater watershed.

OBJECTIVES

This research integrated the concepts of vulnerability and resilience with an assessment of risks and assets for the purpose of understanding what livelihood strategies affect the adoption of SWC practices. The objectives were to 1) identify relationships between livelihood vulnerability and adoption of SWC practices and 2) relate livelihood vulnerability conditions for improving SWC implementation in the Kapolet and Moiben subwatersheds.

The incorporation of the livelihood vulnerability data may identify areas unsuitable for the implementation of SWC practices despite their physical suitability. Identifying areas with high vulnerability may reveal other issues that require resolution before emphasizing SWC implementation.

METHODS

Participatory rural appraisal (PRA) consists of activities and questions to identify factors of community vulnerability to include natural events, location of these events, land use, land tenure, resource management techniques, gender roles, occupation, education, wealth, community networks, and health issues. Problem and resource ranking are PRA activities that aid in extracting what issues influence peoples' capability and/or motivation to adopt SWC practices. The combined data set from personal observation, key informant interviews (n=8), household questionnaires (n=172) and

participatory rural appraisal activities (n=4) described in the previous chapters is used to understand how vulnerability influences SWC activities.

RESULTS

Table 20 shows the total mean risk index value (1.0 = high risk, 0.0= low risk) and the cumulative SWC percentage and frequency percentage of SWC practices in each study site. Data from chapter 3 are summarized in Table 21 for the Kapolet Region and in Table 22 for the Moiben region.

Table 20 Community Risk and Household Respondent SWC Summary

	Munyaka	Sengwere	Meibeki	Barsombe
Total Risk Index Mean	0.39	0.45	0.37	0.30
mean SWC use	50 %	33 %	46 %	42 %
manure	69 %	31 %	69 %	64 %
terraces	41 %	21 %	22 %	27 %
grass strips	69 %	57 %	47 %	47 %
fallow	20 %	24 %	44 %	31 %

Munyaka

Munyaka had the greatest total SWC adoption rate (50%) and the highest percentage for manure, terrace and grass strip adoption among the study sites (Table 20). Use of manure and grass strips were the most commonly used practices, at 69%. Data collected and analyzed in chapter 2 showed that both manure and grass strips were soil and water management strategies adopted by people who had cattle assets. Manure use was linked with people who had accumulated wealth assets, often including cattle. Cattle provided an easily accessible source of manure and were a source of protein for human consumption in addition to acting as a financial investment. Grass-strips were associated with people who owned crossbred cattle, as owning cattle and managing grass strips are mutually beneficial. The livelihood strategy of cattle and grass strip management was threatened by insecurity, the community's largest concern (Table 14). Risk data from

chapter 3 described insecurity as a risk that affected cattle owners because conflicts with neighboring tribes and subsequent cattle theft resulted in the loss of cattle in the Kapolet region. The loss of cattle assets resulted in an increase in livelihood vulnerability because cattle provided food and financial security to their owners. The increase in livelihood vulnerability with cattle loss, consequently threatened the use and future adoption of both manure and grass strips. Individuals have altered their farming strategies to reduce the risk of losing financial investments by selling their cattle, while the community has sought governmental assistance to increase policing and vigilance to mitigate the insecurity risk. Personal and community actions to mitigate insecurity risks and their other risks are described in Table 21.

The construction of terraces requires a livelihood vulnerability level that can initially allocate human and financial assets for a long-term soil protection investment. Terrace use in Munyaka had the highest adoption rate among the study sites at 41%. The higher adoption rate of terraces in Munyaka was associated with grass strips use as many terraces were planted with napier grass. The steep slope conditions make terracing necessary as farming without them resulted in landslides and erosion. Lands farmed in Munyaka were above the 20% slope grade, which is recommended for terracing by The Soil and Water Conservation Manual of Kenya (Thomas 1997). Along with the topographical need for terracing, Ministry of Agriculture (MoA) extension support was available to help people gain knowledge about the benefits of SWC implementation. The interaction of wealth assets, social capital and agricultural intensification all contributed to the overall higher adoption rate of SWC practices in Munyaka.

In Munyaka, poor communication and loss of soil fertility were two problems debated by participants during the community meetings. People who lived near roads believed communication was not a problem, but they had more concerns for soil fertility loss, stating their farming success depended on maintaining soil fertility. Conversely, a majority of people selected poor communication as a problem over soil fertility because poor communication facilitated other problems (e.g., insecurity, health issues, marketing produce, accessing resources). These differences of concern, when presented in a public forum, exemplify the heterogeneity within a community.

Sengwere

The risks and assets that occurred in Sengwere are likely the result of Sengwere being a relatively new settlement. Livelihood vulnerabilities levels in Sengwere were high because of limited assets and the large number of risks with high severity and incidence. Sengwere had the highest total mean risk index *Rj* value 0.45 among the four study sites (Table 20). Sengwere also had the lowest cumulative adoption rate of SWC practices among the four study sites (Table 20). The high risk index 0.45 and the low SWC adoption rate 33% would suggest that adoption was limited by their high vulnerability level as a result of being a relatively new settlement. Grass strips had the highest adoption rate in Sengwere at 57%. This may be due to the steep slopes where the settlement was located, although no significant relationship was detected between topographic conditions and SWC adoption as described in chapter 2.

Insecurity was the second ranked concern in Sengwere (Table 14). Cattle theft in Sengwere resulted in the loss of one of the few financial assets the people in Sengwere had. This threat can influence SWC adoption when financial assets are required to

implement or buffer the delayed benefits of the practice. Cattle theft unlikely influenced grass strip adoption as it does in Munyaka, because there was not a significant relationship between cattle ownership and grass strip adoption in Sengwere. Livelihood conditions in Sengwere reflected cattle ownership to be low and therefore livelihood strategies of linking cattle, grass strips and fodder had not been exploited.

The overall limited SWC adoption can be associated with the compounding wealth status factors such as low education levels, lack of land titles, small acreage, and low cattle numbers as described in chapter 2. Although, slope conditions in Sengwere required terraces, only 21% of the household respondents indicated terrace use. The statistically significant variables described in chapter 2 explained the low adoption rate of terracing as a likely a result of people in Sengwere not having a property title (93% no title) and a majority of farmers owning less than 7 acres (87.5% < 7 ac). The poverty conditions in Sengwere as reflected in their stated risks also revealed that resources were not available for terrace construction and maintenance. Small plots (risk rank 6^{th}) and low livestock numbers in Sengwere also reflected why fallowing is not a common practice. Ultimately, the limited SWC adoption in Sengwere can be linked to compounding factors associated with their recent resettlement onto their native lands.

Natural resource assets in Sengwere that contributed to their agricultural based livelihoods included fertile soils and remnant trees from the previous government forest plantation. However, these resources will be limited over time given that regeneration activities were not a priority. Prominent assets included the ability of community members to recognize the need for strong leadership and participating in educational opportunities offered by government extension services and non-governmental

organization extension services. Community members were also eager to learn and try new farming techniques.

Heterogeneity within the Kapolet region for both SWC adoption and vulnerability was attributed to the recent settlement of Sengwere. The people in Munyaka had acquired assets to build resilience to their risks through social networks and were taking advantage of government and non-government extension services while the people in Sengwere had yet to capitalize on or build up these assets. Similar risks and assets occurred in both communities; however, the differences in risks related to the relative importance of meeting daily subsistence needs. The difference in SWC adoption rates reflected the assets each community had, while their risks were potential limitations to future adoption.

Table 21. Kapolet Region Household Respondent Summary of Assets and Strategies

	Munyaka (n=49)		Sengwere (n=42)	
Physical Resources	frequency %		frequency %	
cattle dip	10		0	
machinery / posho mill	8		5	
market	65		36	
medical facility	49		24	
police post	2		2	
roads	10		55	
school	80		76	
water structure	8		0	
Social Resources				
church	80		55	
community based organization	49		40	
government extension (agriculture & health)	16		7	
non-governmental organization	8		2	
Insufficient Resource Strategies	Individual	Community	Individual	Community
alter farming strategy	16 %	2 %	21 %	0 %
community-based organization	4 %	10 %	0 %	0 %
cope	29 %	6 %	38 %	2 %
seek education	6 %	33 %	0 %	14 %
seek outside funding	16 %	27 %	9 %	38 %
use alternative resource	20 %	6 %	16 %	12 %
travel far	37 %	8 %	24 %	7 %
seek government assistance	0 %	61 %	0 %	36 %
sell produce locally	0 %	6 %	0 %	0 %
prevention activities	0 %	6 %	0 %	10 %
collect funds locally	0 %	6 %	0 %	14 %

Meibeki

Manure was the predominant SWC practice in use in Meibeki and high inorganic fertilizer use indicated farmer's needs to supplement their existing soil fertility conditions (Tables 8 and 20). As described in chapter 2 manure use was associated with at least an average wealth status, as use increased with increasing education levels and having a property title. Along with having a higher education level and a property title, the application of manure needs time, labor, and a manure source for farmers who used manure compost to maintain or increase soil fertility. Livelihood strategies were geared towards securing financial capital (e.g., money, cattle, labor) to ensure soil fertility

through manure use or inorganic fertilizer use. Soil fertility loss and erosion were problems in Meibeki, but were ranked 14th of 18 total identified risks (Table 14).

Livelihood vulnerability conditions reflected that certain assets (e.g., financial) were invested in preventing agricultural risks that supported households' daily subsistence. Due to assets being drawn upon to sustain agricultural production other risks became more significant as livelihood strategies were not focused on them. The top ranked risk in Meibeki was disease and health issues (Table 14). Table 22 indicates the percentage of strategies used on individual and community wide basis as described by household interview respondents. On an individual basis people tended to cope, travel long distances and used alternative resources to mitigate their risks. Specific community responses to health problems included seeking outside assistance to assist with prevention, sensitization activities and acquiring funds to improve existing medical facilities. The risks and assets that formed Meibeki's vulnerability level may not be directly linked to SWC adoption, but these risks and limited assets contributed to the collective livelihood strategy each household employed that in turn helped determine the choices people made regarding their land use practices.

Barsombe

Conditions in Barsombe were very similar to Meibeki in terms of the agricultural system and water shortage conditions. Water shortage was the overriding risk in Meibeki, whereas the other 13 risks identified by community participants and reported in Table 14 did not represent high severity or incidence within the community. Barsombe represented the study site with the lowest total mean risk index *Rj* value and the second lowest cumulative SWC rate (Table 20). Agricultural systems in Barsombe reflected

intensive maize production based on hybrid seed and fertilizer use. SWC activities were only employed if they were perceived as cost effective means of improving immediate crop production. Manure represented a soil fertility management practice with the highest use, while inorganic fertilizer was primarily used to enhance short-term soil fertility conditions. Households with sufficient wealth assets were likely to invest in longer-term SWC activities that were perceived to improve crop production and profits. Manure, grass strips, terracing and leaving the land fallow were all practices that either improved soil fertility or reduced soil loss. However, these benefits were delayed after initial implementation costs were spent making adoption less feasible for farmers with limited buffering assets.

Despite similarities between the two locations, differences occurred with livelihood vulnerability levels, as risks and assets weighed differently between the locations. Poor communication infrastructure was the second ranked risk in Barsombe, although the risk index value was 0.48 because it was not considered a risk that affected a large percent of the community (Table 14). Out of the four study sites, Barsombe was located closest to tarmac roads and a large market at Tuigoin Center. Barsombe was also the only location to have semi-reliable mobile phone reception, which is becoming an important communication tool for farmers to monitor market conditions and arrange crop transportation making the importance of communication access even more apparent. The people in Barsombe utilized their current communication resources but communication was especially limited during the rainy seasons when roads were impassable. Increased communication efficiency assisted farmers with produce marketing and securing financial assets by having easier access to alternative employment opportunities, credit

institutions and information on improved agricultural techniques. Increased communication can allow farmers to acquire assets from outside of the community to improve their financial risk resilience. Although, risk index values were not high for a majority of the identified risks, limited assets increased households' and community's vulnerability level, as resources were not available to mitigate and build resilience for some risks.

In Barsombe, household interviews and personal observations indicated a shortage of social capital, specifically governmental services. The number of community-based organizations ranked lowest among the four study sites as a resource available to them, and no one indicated government extension or non-governmental organization extension services as an available resource (Table 22). Community participants indicated that they have never been recipients of development projects or development extension services. The lack of social capital increased the community's vulnerability level as compared to the other study sites that were able to use social networks to help mitigate their risks that indirectly influenced SWC adoption such as community self-help groups that acted as money saving and labor resource pools. The social capital deficit in Barsombe impacted SWC adoption as MoA extension services were not deemed a resource. The lack of social capital prevented building community resilience to risks concurrently the ineffective extension services were not facilitating growth of social networks. The limited social capital prevented people from using these networks to mitigate their risks and improve their asset base that could have alleviated some of the constraints to SWC adoption. Households in Barsombe were likely to

employ strategies to lessen their livelihood vulnerability on an individual basis instead of relying on community services to moderate them.

In the Moiben region, water shortage was a major risk to peoples' livelihoods. Water shortage directly and indirectly affected households' farming strategies, daily subsistence needs, individuals' health and the accumulation of wealth assets. This then resulted in allocation of resources away from SWC practices and towards securing water.

Table 22. Moiben Region Household Respondent Summary of Assets and Strategies

	Meibeki (n=36)		Barsombe (n=45)	
Physical Resources	frequency %		frequency %	
cattle dip	14		18	
machinery / posho mill	22		0	
market	42		51	
medical facility	56		56	
roads	69		49	
school	81		62	
water structure	5.6		0	
Social Resources				
church	56		53	
community based organization	31		16	
government extension (agriculture & health)	14		0	
non-governmental organization	28		0	
Insufficient Resource Strategies	Individual	Community	Individual	Community
alter farming strategy	6 %	6 %	11 %	7 %
cope	42 %	11 %	40 %	20 %
participate in illegal activity	3 %	0 %	0 %	0 %
seek education	0 %	22 %	2 %	7 %
seek outside funding	8 %	22 %	18 %	7 %
use alternative resource	22 %	28 %	18 %	60 %
travel far	36 %	6 %	49 %	7 %
seek government assistance	3 %	11 %	0 %	0 %
prevention activities	0 %	16 %	0 %	4 %
collect funds locally	0 %	14 %	0 %	16 %

DISCUSSION

Social Capital

Social networks are important for the process of SWC practice information dissemination as demonstrated by both regions relying on SWC information exchange

through family, friends and neighbors (Table 12). The level of participation in networks may result from other social conditions and therefore social capital does not stand alone in determining one's vulnerability. Place et al. (2001:9) notes the positive relationship between the adoption of natural resource conservation activities and "communities' capacity to organize cooperatives and rates of acquisition of new information and investment in improved practices." The exchange of goods, services, and information through social networks maintains relationships that provide households with access to resources, economic incentives and may encourage resource conservation (Thomas-Slayter and Rocheleau 1995).

Vulnerability Heterogeneity

Vulnerability heterogeneity exists within and across study sites. Some households struggle to meet their basic needs, others have yet to accumulate the correct combination of assets to reach a SWC investment level and others have built enough resilience and gained enough knowledge about SWC practices to implement them. SWC practices are usually investments for long-term soil fertility enhancement or soil retention, which require an initial cost in time, labor, land, and money. The benefits of these practices accumulate over time and may not result in immediate crop production profits. For farmers whose vulnerability levels were high, adoption may be limited because of the unknown cost/benefit value of the SWC implementation or because their risk resilience was not strong enough to draw upon assets to implement SWC practices (Kerr and Sanghi 1997). Low vulnerability levels could be implied with wealthier farmers who have enough assets to invest in SWC and have established resilience to cope with potential risks (Reardon and Vosti 1995). Risks and assets contribute differently to

livelihood vulnerability depending on the location. The assets that are required in one site to move people beyond investment poverty levels may not be the same in another site, just as risks may not be equally mitigated between sites.

Low crop production is often a result of low soil fertility and soil fertility is often managed by inputs of organic and inorganic fertilizers. However, manure availability and financial limitations of purchasing inorganic fertilizer makes soil fertility management difficult. Agricultural intensification incorporating SWC measures can improve soil fertility by using SWC practices that offer multiple benefits. Napier grass strips can improve soil fertility by erosion control and providing nutritional fodder to livestock for greater manure production (Muyekho et al. 2003). In Western Kenya, Connelly and Chaiken (2000) found agro-diversity to be a strategy for coping with land scarcity which utilizes limited resources in multiple ways to maximize and secure production. In the three study sites that identified land shortage as a problem in their area (Sengwere, Meibeki and Barsombe), none of them emphasized diversifying crop production as a method of improving their livelihood vulnerability.

Vulnerability in Munyaka

Adoption of SWC is often a strategy employed by households to intensify and improve the resilience of their farming system (Boyd et al. 2000). In Munyaka, farmers' adoption of grass strips and manure represented their attempt to intensify their farming system. However, the recent cattle theft insecurity disrupted this farming strategy, resulting in a loss of financial capital. In Uganda, Boyd et al. (2000) found that conflict with neighboring tribes and cattle theft were also problems where there was a noted impact on people's livelihoods with the loss of cattle assets. This loss of assets reflected

a livelihood vulnerability level that negatively affected the capacity at which families could invest in their farming system since loss of cattle leads to the inability to implement or maintain SWC practices to increase soil fertility and reduce erosion (Boyd et al. 2000). Conditions in Munyaka showed a temporary resilience to the cattle theft risk because of their use of social networks and diversifying their farming strategies. However, the continual threat of cattle theft will likely reduce their livelihood vulnerability because of the strain upon their assets and eventually will reduce their ability to implement SWC practices.

Vulnerability in Sengwere

The natural, physical and social conditions in Sengwere contributed to their high livelihood vulnerability made SWC adoption difficult. However, because of their demonstrated interest in improving their livelihoods based on their lack of resources, SWC adoption may be viewed as a method to reduce vulnerability if initial assistance (e.g., knowledge and implementation tools) is gained through extension services. SWC practices may be incorporated as a farming strategy necessary to improve their resilience and overall livelihood conditions. Knowledge from extension outreach activities may enable households to participate in new activities that may result in higher agricultural returns, and thus higher returns in assets (Barrett and Swallow 2004). As community leadership and trust grows in Sengwere the development of social capital may also help overcome wealth limitations. With time, people develop new strategies to cope with risk and natural resource management often by "mitigating its effects on their livelihoods or by rehabilitating degraded resources" (Scherr 2000:482).

Vulnerability in Meibeki and Barsombe

"It is often assumed that SWC is undertaken as a risk-reducing investment in the context of vulnerability, but case studies from Tanzania and Uganda both suggest investment is reduced as perceived vulnerability increases" (Boyd et al. 2000:1). The soil fertility management activities in Meibeki and Barsombe were implemented to boost crop production and reduce risk of crop failure with application of organic and inorganic fertilizer. Changing weather conditions in the Moiben region was also considered a risk to farmers' livelihoods (i.e., farmers' feared droughts would result in the loss of both crop and livestock assets). Weather uncertainties causing droughts and floods were a major factor in vulnerability context of both the Ugandan and Tanzanian case studies (Boyd et al. 2000). Variable yields caused by weather fluctuations were one reason preventing SWC adoption in a case study in Uganda and likely limit adoption in the Moiben region because droughts cause low yields resulting in a loss of assets. (Boyd et al. 2000). The individual's perception in how SWC practices reduces or increases risk to their overall livelihood is reflected in adoption rates (Boyd et al. 2000).

CONCLUSION

Knowledge Acquisition

It is important to know what assets the community draws upon to build livelihood strategies when determining where to invest to improve conditions (Bebbington 1999). Knowledge about SWC techniques and implementation methods is an asset that can be enhanced and utilized more effectively in all of the study sites. Nevertheless, where people receive their knowledge from and the quality of this education resource varies and this can limit participation and the acceptance of new information. Based on the data gathered from the two regions, it may be more effective to contribute towards improving

the MoA officers' capacity to assist the Kapolet communities' members with managing their vulnerabilities than in investing in the Chief's resources. Recommendations for the Kapolet region include a continuation of the current governmental and non-governmental extension services and improving their ability to promote community education events and farmer field days. The pre-established networks formed during these educational workshops may help strengthen community ties and build the communities' resilience to risk. In Moiben, assisting the Chiefs with their community service would be more beneficial than investing in the MoA officers. However, increasing the number of MoA extension personnel and improving their ability facilitate SWC education through individual farmer interactions and workshops may increase the knowledge base at which information is disseminated through networks of family and friends.

Extension Upgrade

Extension services need to account for livelihood conditions in their management area on both a community scale and on a household scale when determining appropriate agricultural services and development needs. The varied risk to agriculture production and sustainable livelihoods often creates a deficit in natural, human, and financial capital. To reduce poverty in the agricultural sector extension officers must include multiple socioeconomic groups in their services, while recognizing that not all people have the assets to implement new technologies or adopt new farming strategies. Working with asset limited households may help develop new methods of intensifying agriculture and environmental conservation based on the available assets. Information disseminated by extension must be applicable given the potential risks and available assets in the target community. Extension investment could also be focused on strengthening and increasing

participation in community-based organizations. In both regions, community-based self-help groups acted as assets that mitigate tangible risks given the collective individual assets each member contributes.

SWC Potential in Kapolet

In the Kapolet region, Munyaka and Sengwere had severe risks that limited SWC. Livelihood conditions in Munyaka allowed farmers to use their assets to mitigate these risks, therefore their overall vulnerability levels were not high enough to prevent SWC adoption but also not low enough to guard against risks affecting their farming strategies. The social capital (e.g., MoA extension, Vi Agroforestry organization and community-based groups) present provided support for reducing vulnerability levels and encouraging the adoption of SWC practices. Even though Sengwere had the lowest SWC adoption rate and the highest risk index value, their livelihood vulnerability level reflected assets, specifically community mobilization and MoA extension services, which may support future SWC adoption as vulnerability reducing strategies. The community mobilization for governmental representation may assist in obtaining physical infrastructure along with individual title deeds that will give the Sengwer a sense of land security. The situation in Sengwere showed strong support for a continual growth in social capital and willingness to try new farming strategies as a method to improve livelihoods.

Soil erosion potential was high in the Kapolet region because of the agricultural activities on steep slopes, which contributed to poor water quality conditions. Vulnerability levels in the Kapolet region indicated SWC efforts are likely to be well received and adopted as farmers move towards agricultural intensification to secure their assets. Specifically, in Munyaka intensified farming and diversification were enabling

farmers to gain assets to adopt SWC measures. Extension efforts in Munyaka should continue supporting community groups and farmer trainings while also working with individual farms to help them determine the best strategy to enhance their assets. Similar intensification processes that were occurring in Munyaka could be encouraged by extension personnel working in Sengwere. However, high investment practices (e.g., terraces) are not likely to be adopted because of their small farm plots, limited financial assets and government policy induced land insecurity in Sengwere. Extension services in Sengwere should offer knowledge-based, low asset, investment options. This type of extension service may give people more options to meet their household consumption needs while potentially providing agricultural profits.

SWC Potential in Moiben

Conditions in the Moiben region reflected a high vulnerability level that limited SWC adoption, as assets did not exist to mitigate their major risks. Available assets were spent on reducing immediate risks such as water collection and soil fertility maintenance with organic or inorganic fertilizer. Investing assets into longer-term SWC strategies were tenuous because of the unknown weather risks and the continual demand for immediate risk reduction. Agriculture and development extension services were not assets used to reduce vulnerability and encourage SWC adoption. Reorganization, training and prioritization of extension activities within MoA may increase the capacity of extension officers to offer services to their respective communities. With the help of knowledgeable MoA officers, farmers may understand how their land use activities contributed to their water shortage risk while learning about water conservation activities.

Soil erosion potential was high in the Moiben region because of high livestock traffic to water sources and the lack of vegetation. Vulnerability levels in the Moiben region indicated low receptivity to SWC efforts because of the low regard for extension services and past enforcement of SWC practices. Development efforts need to focus on working with each community to determine the best method to decrease excessive travel for securing water by people and livestock and to improve water quality. Water stations may help alleviate some of the most visible soil erosion caused by high livestock traffic along roadsides to the Moiben River. Land use management activities in the Moiben region should focus on reducing livelihood vulnerability on a community level. Working with local Chiefs to improve social networks within the community may help build risk resilience and free assets for allocation to SWC adoption. Mobilization of community members to address the water shortage problem as a community risk instead of coping with the problem on an individual basis may help reduce the overall risk on individuals' livelihoods.

Land Use Management

Farming systems reflected distinct agro-ecological zones, historical land allocations and land use activities in each region. Biophysical, political and social conditions all contributed to the varying vulnerabilities and the relationship with SWC adoption within the regions. Site-specific vulnerability analysis showed how risks and available assets in each study site influenced the strategies farmers' used to best manage their livelihoods. The types of strategies people utilized to deal with unavailable essential resources and the management of available resources are key factors in the potential adoption of new land use practices. Land use management plans need to incorporate the

individual and collective strategies that improve livelihood conditions that subsequently enable SWC adoption. Where coping strategies dominate, outside assistance through development programs, extension services and funding sources may be needed to offset limited assets. The potential success or failure of extension services and new technologies are attributed to available assets and the strategies people use to best manage them (Barrett and Swallow 2004). Given the changing strategies and fluctuating assets, extension services should focus on knowledge-intensive techniques that incorporate local knowledge and resources that will not dissipate when people draw upon their assets to mitigate risks (Barrett and Swallow 2004).

Identification of factors that inhibit and promote the adoption of SWC practices enables advancement of research, development and policies (Place et al. 2001). Previous policies have treated communities and geographic regions as homogeneous and have resulted in a continuation of the poverty-environment cycle. The recognition of heterogeneity within communities may make policy development more difficult, but it accounts for the existence of varying levels of vulnerability that will potentially lead to more sustainable and socially appropriate SWC implementation policies and education efforts. In the Kapolet and Moiben regions, the difference in risk types (e.g., insecurity vs. water shortage) and severity of risks demonstrates how vulnerability varies by location. Assets also contribute to this vulnerability with differences in government support staff (MoA extension vs. Chiefs) between the regions. SWC adoption is influenced by livelihood vulnerability, as risks draw upon individuals' assets and consequently reducing the assets available for SWC investment. The severe risks likely impact poorer households more by drawing down on their limited assets, while wealthier

households address the same risks with more assets to buffer their livelihood vulnerability status. Common risks found within all four study sites represent issues that likely result from external political and economic conditions. Understanding the heterogeneity within communities allows watershed managers to focus on a community's ability to act collectively and/or focus on individual users and their role in soil and water conservation.

RECOMMENDATIONS

SWC activities in the Kapolet and Moiben regions should develop approaches that incorporate regional risks and assets in order to withstand variations in vulnerability. Livelihood vulnerability conditions change continuously and encouraging use of SWC practices with multiple benefits may reduce susceptibility to fluctuating conditions. Continual use of participatory research, education and action methods can build on local knowledge to create site-specific SWC practices. These practices should provide benefits that strengthen farmers' assets while contributing to conservation needs. Small acreage size farms require appropriate and practical SWC options. Improving watershed water quality and quantity requires more viable conservation options for a large number of households. SWC efforts need to address the roles of both men and women and their distinct concerns regarding their livelihood sustainability. SWC methods that address agriculture production problems may be more favorable among men, while women might support SWC methods that save time and provide household benefits.

Grass strips represent one SWC practice that can meet site-specific needs, while providing multiple benefits to the adopter. Since almost every farmer has access to some type of manure, training on improved methods of composting and application to household gardens would increase vegetable production and provide nutritional and health benefits to families. Conservation methods that improve soil fertility on a small scale may help reduce risks and allow reallocation of other assets for larger scale SWC adoption. Topographic conditions in the Kapolet region demand for the use of terracing, but limited assets preclude their widespread use. Encouraging cooperation between farmers to use terraces as plot delineations for property lines may help resolve the

adoption constraint of limited acreage. In addition, encouraging combined use of grass strips and terracing will help farmers realize the benefits of implementation. The intensity of agriculture in both regions limits the opportunity for land to lay fallow. However, enforcement by local chiefs of the recent riparian buffer protection regulation will aid in achieving improved water quality protection by leaving riparian areas fallow. Agroforestry and reforestation activities will provide both regions key resources (e.g., windbreaks, fuel, building materials) while aiding in SWC.

Results from both regions indicate the role knowledge has for both understanding the purpose and implementation of SWC practices. Increasing peoples' access to SWC education may influence perceptions about SWC purpose and enable people with the essential assets to adopt. Knowledge is a resource that cannot be lost from impending risks, but knowledge resources do fluctuate with changing government systems. The MoA needs to train and place extension officers in culturally appropriate locations where they can form relationships with community members for a long-term commitment. MoA extension officers should be recognized and rewarded for effective service. A system of community-wide incentives may also help encourage farmers to persuade others to adopt SWC measures, especially when direct benefits are difficult to detect on an individual basis.

Risks with high severity and incidence should be addressed through government and development agency support (e.g., investments in physical infrastructure, communication, and education improvements). Mitigation of other risks should be encouraged at a local level using existing community resources. Local level leadership requires consistent support by regional governing agencies. As community groups

attempt to resolve local issues, facilitation by a person from outside the community may help establish the importance of peoples' participation in community efforts. It is important for this facilitator to demonstrate fairness, dependability and commitment to a long-term involvement to help promote local leadership.

FUTURE RESEARCH

The sustainable livelihood framework was used to help understand how the interactions between risk and assets influence SWC adoption. Further research may explore cultural preferences for farming strategies and how these strategies are adapted to fit local conditions after tribes have been relocated to different agro-ecological regions. A review of government policies and market conditions would also add clarification for why certain farming strategies are employed.

Participatory rural appraisal activities are a common tool used in rural Kenyan settings and are expected and accepted by rural residents. Further research should continue to build on participatory approaches and might include evaluation of specific indigenous SWC methods. Research based on participatory local knowledge will help create SWC practices that reflect site-specific needs combined with proven conservation technologies. Further evaluation of the enforcement of the riparian buffer regulation and its impact on local users will aid in determining how new SWC strategies are perceived.

Continued research could evaluate the role of community-based groups and how these groups specifically function in relation to livelihood vulnerability. This study may identify whether community-based groups serve as a resource for conservation initiatives. Research involving incentive-based conservation adoption will aid in recognizing what incentives are appropriate without creating dependence on outside financial aid.

RESEARCH LIMITATIONS

Several limitations became apparent during the data collection and analysis of the regions risks and assets. Due to methodology and time constraints, data collection did not include more in-depth understanding of specific coping strategies for each risk. Gender risks and assets access could have focused specifically on understanding gender-specific responses to risk. Time was also not allocated to understanding the intricacies of the community-based groups in each community (e.g., how they function, who is involved, who is not involved, what obstacles they face, and why they formed). Data were collected during a politically charged environment, as campaigns for a new constitution were underway; so no data were collected around sensitive political topics under current dispute.

Community meetings may or may not have represented a cross-section of the community population and likely consisted of people who live closer to the village center. The use of translators prevented spontaneous evaluation or discussion of a topic during community meetings. I found that the research assistants often simplified situations and failed to record unique stories, which would have added to the value of the dataset. Time was also not allocated to check my data interpretations with the people the data represent.

APPENDIX A

HOUSEHOLD INTERVIEW QUESTIONS

Vulnerability Analysis of Soil and Water Conservation Adoption: Nzoia Basin, Kenya
Household Questionnaire*

1) Interviewer

2) Date:

3) Time:

4) Where is the interview taking place?

5) Geography: 1=hilltop, 2=shoulder, 3=mid-hill, 4=foothill, 5=valley, 6= flat

6) Living Conditions: (Poor Average Wealthy)

7) Tribe:

8) Male / Female

9) VILLAGE:

10) LOCATION/SUB-LOCATION:

11) Who is the head of household?

12) Age?

13) Level of education: 0=none, 1=primary, 2=secondary, 3=post-secondary, 4=adult

14) Number of children?

15) Number of people living in the household?

16) Part-time occupants?

17) Primary employment?

18) (Besides farming) What other ways do you earn money or goods?

19) Why do you live here (besides buying or inheriting the land), what is special about this place?

20) In this community, how do people determine wealth status?
List characteristics of: Poor, Average, Wealthy

21) What specific resources does your family have?

21a) Natural?

21b) Physical?

21c) Social?

21d) What kind of organizations, church groups, NGOs, extension etc.

21e) How do these organizations function?

21f) What makes them important to this community?

21g) Who has access to these resources?

21h) How are these resources limited to you? (distance, supply, owner etc.)

22) Does your household have enough resources?

23) If not, what resources do you lack?

24) What do you do about them?

25) Does your household suffer from natural disasters?

26) What problems does the village face as a whole?

27) What has been done to address these problems?

28) What do you think are the causes of land use problems?

29) What and where is your water source? Clean water?

30) Do you farm on other plots of land? Why? What crops?

31) What crops bring in the most money?

32) In a normal year, do you produce enough food for your family?

33) How did you acquire this land?

34) What year did you acquire this land?

35) What did the land look like when you acquired it?

36) Do you have a property title to this land?

37) Do you hire people to work on your farm?

38) How many # Temporary, Permanent or Groups?

39)Animal Type	#	How fed? (zero-grazed, tied up, grazed on own or neighbor's pasture, on fallow plots, on common land, fed cut grass, etc.)
Native Cattle		
Cross-bred cattle		
Goats		
Sheep		
Donkeys		
Pigs		
Chickens/Ducks		

40) What are your agricultural related problems?

41) What do you do about them?

42) What soil and water conservation practices do you use?

43) Do you use any of the following techniques?	Why? What benefits and disadvantages do they have?	Used on what crops?	Have you increased or decreased usage? Why?
Household residues-			
Animal manure-			
Stone bunds-			
Fanya juu terraces-			
Erosion trench-			
Grass lines-			
Fallow periods-			
Native plants-			
Chemical fertilizers-			
Pesticides-			
Other-			

44) How did you learn about the techniques?

45) How fertile is the soil on your fields? 1= low, 2= medium, 3= high

46) Has soil fertility increased or decreased?

47) Why do you think so?

48) How many months do you have crops on your fields?

49) What do you use to cultivate your fields? 1= ox plough, 2= tractor, 3= hoe

50) Is erosion a problem, why?

51) Have there been any NGO or government Soil and Water Conservation programs?

51a) Who participated and why?

52) Do some farmers use Soil and Water Conservation practices and others do not?

52a) Why do some use SWC & others do not?

53) Are there land use or farming practices that are culturally prohibited (taboo) in this area or to your tribe?

* Maitima, J. M. and J. Olson 2001. Guide to Field Methods for Comparative Site Analysis for the Land Use Change, Impacts and Dynamics Project. LUCID Working Paper Series Number:15 International Livestock Research Institute, Nairobi, Kenya.

APPENDIX B

KEY INFORMANT INTERVIEW QUESTIONS

Key Informant Interview Questions

1) What hardships do communities face?

2) What organizations help or provide support for these hardships?

3) What strengths do communities have?

4) How and why are communities' chosen for extension services?

5) What is the biggest struggle in working with communities?

6) What SWC extension services have been disseminated in the communities?

7) What aids or hinders people from implementing SWC activities?

8) What other sources do communities have for obtaining information on SWC practices?

APPENDIX C

ORAL CONSENT SCRIPT

Vulnerability Analysis of Soil and Water Conservation Adoption: Nzoia Basin, Kenya
Oral Consent Script

I am conducting research about people's capabilities and motivations to implement soil and water conservation practices within the Nzoia basin. I am a student at Michigan State University, with interest in agriculture and watershed management. The information I will collect and the process of collection is part of my educational training and Master's thesis work and is in collaboration with Moi University. The purpose of this research is to be able to identify areas within the Nzoia basin where SWC activities can be implemented based on livelihood conditions.

As a resident of this local community you are invited to participate in community interview activities and/or household interviews. The community activities will take several hours while the personal interviews may take up to an hour. Your participation in this study is voluntary and you may decide to not participate at any time. If you agree to participate, all the information you provide is confidential and your privacy will be protected to the maximum extent allowable by law. Your name, audio recordings and any other information you provide will not be connected to your identity in any written reports about this study. If you agree to allow the interviews to be audio recorded your name will not be recorded on the tape, these tapes will be kept secured until transcribed and destroyed.

The investigators will be the only persons with access to the information provided during these interviews. Your participation in this study is expected to have minimal risk as your identity will only be known by the investigators. Possible benefits from participating in this research include identifying community strengths and weaknesses and collectively identifying solutions to problems, while stimulating community discussions. This process is an initial step in creating sustainable solutions to be included in a future watershed management plan.

If you have any concerns or questions about your participation or about the study, please contact me:
Heather Patt, Safaricom # 0723113965 or email pattheat@msu.edu
or Dr. Geoffrey Habron (habrong@msu.edu). 517-432-8086
Dept. Fisheries and Wildlife, Michigan State University, East Lansing, MI 48824 USA..
If you have any have any questions about your rights or role as a participant in this study, you may contact Dr. Peter Vasilenko, University Committee on Research Involving Human Subjects (UCHRIS) at 517-355-2180, UCHRIS@msu.edu or 202 Olds Hall, East Lansing, MI 48824 USA.

Your oral consent indicates your voluntary agreement to participate in this study.

_____ _____

Consent (marked by investigator) Date

APPENDIX D

UNIVERSITY COMMITTEE ON RESEARCH INVOLVING HUMAN SUBJECTS APPROVAL LETTERS

MICHIGAN STATE
UNIVERSITY

Initial IRB Application Approval

June 8, 2005

To: Geoffrey HABRON
13 Natural Resources

Re: **IRB # 05-481** Category: EXPEDITED 2-6, 2-7
Approval Date: June 7, 2005
Expiration Date: June 6, 2006

Title: SOCIAL ASSESSMENT OF THE NZOIA WATERSHED, KENYA

The University Committee on Research Involving Human Subjects (UCRIHS) has completed their review of your project. I am pleased to advise you that **your project has been approved**.

The committee has found that your research project is appropriate in design, protects the rights and welfare of human subjects, and meets the requirements of MSU's Federal Wide Assurance and the Federal Guidelines (45 CFR 46 and 21 CFR Part 50). The protection of human subjects in research is a partnership between the IRB and the investigators. We look forward to working with you as we both fulfill our responsibilities.

Renewals: UCRIHS approval is valid until the expiration date listed above. If you are continuing your project, you must submit an ***Application for Renewal*** application at least one month before expiration. If the project is completed, please submit an ***Application for Permanent Closure***.

Revisions: UCRIHS must review any changes in the project, prior to initiation of the change. Please submit an ***Application for Revision*** to have your changes reviewed. If changes are made at the time of renewal, please include an ***Application for Revision*** with the renewal application.

Problems: If issues should arise during the conduct of the research, such as unanticipated problems, adverse events, or any problem that may increase the risk to the human subjects, notify UCRIHS promptly. Forms are available to report these issues.

Please use the IRB number listed above on any forms submitted which relate to this project, or on any correspondence with UCRIHS.

Good luck in your research. If we can be of further assistance, please contact us at 517-355-2180 or via email at UCRIHS@msu.edu. Thank you for your cooperation.

Sincerely,

Peter Vasilenko, Ph.D.
UCRIHS Chair

c: Heather Patt
16 Natural Resources

OFFICE OF
RESEARCH ETHICS AND STANDARDS
University Committee on Research Involving Human Subjects
Michigan State University
202 Olds Hall
East Lansing, MI
48824
517/355-2180
FAX: 517/432-4503
Web:
www.humanresearch.msu.edu
E-Mail: ucrihs@msu.edu

MICHIGAN STATE
UNIVERSITY

Revision Application Approval

September 19, 2005

To: Geoffrey HABRON
13 Natural Resources

Re: **IRB # 05-481** Category: EXPEDITED 2-6, 2-7
Revision Approval Date: **September 17, 2005**
Project Expiration Date: **June 6, 2006**

Title: SOCIAL ASSESSMENT OF THE NZOIA WATERSHED, KENYA

The University Committee on Research Involving Human Subjects (UCRIHS) has completed their review of your project. I am pleased to advise you that **the revision has been approved**.

Revision to include changes in the instrument(s).

The review by the committee has found that your revision is consistent with the continued protection of the rights and welfare of human subjects, and meets the requirements of MSU's Federal Wide Assurance and the Federal Guidelines (45 CFR 46 and 21 CFR Part 50). The protection of human subjects in research is a partnership between the IRB and the investigators. We look forward to working with you as we both fulfill our responsibilities.

Renewals: UCRIHS approval is valid until the expiration date listed above. If you are continuing your project, you must submit an ***Application for Renewal*** application at least one month before expiration. If the project is completed, please submit an ***Application for Permanent Closure***.

Revisions: UCRIHS must review any changes in the project, prior to initiation of the change. Please submit an ***Application for Revision*** to have your changes reviewed. If changes are made at the time of renewal, please include an ***Application for Revision*** with the renewal application.

Problems: If issues should arise during the conduct of the research, such as unanticipated problems, adverse events, or any problem that may increase the risk to the human subjects, notify UCRIHS promptly. Forms are available to report these issues.

Please use the IRB number listed above on any forms submitted which relate to this project, or on any correspondence with UCRIHS.

Good luck in your research. If we can be of further assistance, please contact us at 517-355-2180 or via email at UCRIHS@msu.edu. Thank you for your cooperation.

Sincerely,

Peter Vasilenko, Ph.D.
UCRIHS Chair

c: Heather Patt
16 Natural Resources

OFFICE OF
RESEARCH ETHICS AND STANDARDS
University Committee on Research Involving Human Subjects
Michigan State University
202 Olds Hall
East Lansing, MI
48824
517/355-2180
FAX 517/432-4503
Web:
www.humanresearch.msu.edu
E-Mail: ucrihs@msu.edu

MICHIGAN STATE
UNIVERSITY

Renewal Application Approval

May 23, 2006

To: Geoffrey HABRON
13 Natural Resources

Re: **IRB # 05-481** Category: EXPEDITED 2-6, 2-7
Renewal Approval Date: May 23, 2006
Project Expiration Date: May 22, 2007

Title: SOCIAL ASSESSMENT OF THE NZOIA WATERSHED, KENYA

The Institutional Review Board has completed their review of your project. I am pleased to advise you that **the renewal has been approved**.

This project has been approved for data analysis only.

The review by the committee has found that your renewal is consistent with the continued protection of the rights and welfare of human subjects, and meets the requirements of MSU's Federal Wide Assurance and the Federal Guidelines (45 CFR 46 and 21 CFR Part 50). The protection of human subjects in research is a partnership between the IRB and the investigators. We look forward to working with you as we both fulfill our responsibilities.

Renewals: IRB approval is valid until the expiration date listed above. If you are continuing your project, you must submit an ***Application for Renewal*** application at least one month before expiration. If the project is completed, please submit an ***Application for Permanent Closure***.

Revisions: The IRB must review any changes in the project, prior to initiation of the change. Please submit an ***Application for Revision*** to have your changes reviewed. If changes are made at the time of renewal, please include an ***Application for Revision*** with the renewal application.

Problems: If issues should arise during the conduct of the research, such as unanticipated problems, adverse events, or any problem that may increase the risk to the human subjects, notify the IRB office promptly. Forms are available to report these issues.

Please use the IRB number listed above on any forms submitted which relate to this project, or on any correspondence with the IRB office.

Good luck in your research. If we can be of further assistance, please contact us at 517-355-2180 or via email at IRB@msu.edu. Thank you for your cooperation.

Sincerely,

Peter Vasilenko, Ph.D.
SIRB Chair

cc: Heather Patt
16 Natural Resources

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202 Olds Hall
East Lansing, Michigan
48824-1046
517-355-2180
Fax 517-432-4503

www.humanresearch.msu.edu
SIRB & BIRB: IRB@msu.edu
CRIRB: crirb@msu.edu

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