LUCID's Land Use Change Analysis as an Approach
for Investigating Biodiversity Loss and Land Degradation Project

Guide to Field Methods for Comparative Site Analysis for the Land Use Change, Impacts and Dynamics Project

LUCID Working Paper Series Number: 15

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A. INTRODUCTION

This is a manual to guide fieldwork activities for the LUCID project, entitled "Land Use Change Analysis as an Approach for investigating Biodiversity Loss and Land Degradation." The project is being implemented in three east African countries (Kenya Uganda and Tanzania) and in four specific research sites (Kilimanjaro Kenya; Kilimanjaro Tanzania; Southwest Uganda and Embu-Mbeere Kenya. Each site has a working team to carry out research activities as required in the project document. The team comprises of a site leader, scientists and students.

The goal of the LUCID project is to provide methodological advice on how to use land use change analysis to identify and monitor changes in biodiversity and land degradation. As such, the project will prepare a methodological guidebook by the end of the three year period. A secondary goal of the project is to provide information on the linkages between land degradation, biodiversity and land use change based on East African information.

The objectives of the project's fieldwork are therefore two fold: 1) to test and refine methods, and 2) to provide scientific information on the linkages between land use change, and changes in biodiversity and land degradation for each site. It is hoped that these two objectives may be met using previously gathered information as much as possible. The socio-economic component of the research will be particularly based on existing data, and on team members' reflections of various methods that they have experienced. In order to have cross-site comparability of the linkages, however, ecological information in particular needs to be collected in a common framework in each site. This information and data collection methods to ensure cross-site comparability are in this paper.

The purpose of this manual is to harmonize procedures for field data collection in different sites to enable cross-site comparison of the results and generation of a regional synthesis.

Part I of this manual provides working definitions of land use, land degradation, and biodiversity that will guide field data collection, site analysis and the subsequent synthesis into regional perspectives. Part II outlines the parameters to be measured, data sets required and the methods to measure parameters that will be applied to all sites. Biodiversity parameters that are being measured in one or two sites only are not included in this manual because in many of these cases most of the data was collected previously. We recommend that researchers in these sites should consult each other to discuss compatibility of their data sets.

B. WORKING DEFINITIONS

B.1. Land use

Land use represents the human use of the land. Examples of classes are small-scale agriculture, grazing, wildlife reserves or industrial zones.

B.2. Land cover

Land cover represents the biophysical cover. Examples of classes are savannah, broadleaf forest, tea or built up areas. In the new land use/ cover interpretations that we will do during the project, for example in the transects and interpretation of new satellite imagery, we will be using the classification system designed by the Africover project (which is a system based on previous FAO system).

This project will examine changes to land use and its impact on land cover at different scales: the field level (e.g., transect plots, fields) and at scales determined by the resolution of aerial photographs and satellite imagery (ranging from 1:20,000 to 1:100,000). The field data collected will thus include information on the class of land use and land cover of each area surveyed.

This field guide focuses on the field data collection of the project. Remote sensing analysis, statistical analysis and other analytical methods will be described in a separate guide.

B.3. Biodiversity

Biodiversity is defined by the Convention on Biological Diversity as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems" (http://www.biodiv.org/).

In the LUCID project, the working definition of biodiversity is the variability and distribution of above ground, terrestrial flora and fauna species, both natural and human managed. An emphasis will be placed on measuring vegetative species and ecosystem diversity, because changes in vegetation are more easily determined and are directly impacted by alterations of land use. Factors of vegetative biodiversity and ecosystem diversity that affect wildlife, such as changes in habitat extent and fragmentation, vegetative composition and structure, and wildlife corridors will be measured and interpreted in terms of their impacts on wildlife.

Indicators of changing biodiversity that will be examined include:

- Changing availability of important plant resources (medicinal plants, plants used for handicraft purposes, pollen producing plants for bees) as noted by key informants
- Comparison of flora and fauna in land use/cover classes representing different levels of human disturbance
- Changes in habitat extent, distribution and fragmentation determined by interpretation of remote sensing data.

B.4. Land Degradation

The U.N. Convention to Combat Desertification definition for land degradation, which is the definition adopted by GEF, is as follows:

> Land degradation is a 'reduction or loss, in arid, semi arid and dry sub humid areas of biological or economic productivity or complexity of rainfed cropland, irrigated cropland, or range, pasture, forest and woodlands resulting from land uses or from a process or combination of processes, including process arising from human activities and habitation patterns such as: soil erosion caused by wind and /or water; deterioration of the physical, chemical and biological or economic properties of; and long term loss of natural vegetation.

The Participants of LUCID workshop held in February, 2001 considered the above definition and developed a working definition of land degradation as follows:

> *Land:* Land means the terrestrial bio-productive system that comprises soil, vegetation – including crops, other biota, and the ecological and hydrological processes that operate within the system.
>
> *Degradation:* Degradation implies a reduction of resource potential by one or a combination of processes acting on the land, such as:
>
> - Soil erosion by wind and/ or water
> - Deterioration of the physical, chemical and biological or economic properties of soil.

However, due to several limitations of the current LUCID-GEF Project, investigations on soil degradation in this project will be restricted to certain physical and chemical properties, and that measurements of biota will be confined to above ground biodiversity.

B.5. Indicators of Land Degradation

There is no commonly accepted measure of land degradation; indeed a group of CG scientists has spent several years attempting to produce a measurable definition and common indicators. Many projects, such as the UNEP-GEF PLEC (People, Land, and Environmental Change) project, confine their measurements to traditional soil chemical properties and soil erosion indicators without using a broader measurement of land productivity, and without measuring the process over time. Some recent research projects are testing alternative measures, such as soil spectral properties, enzymes, microbial DNA and fatty acids/ lipids, that may provide signals of the process of soil deterioration.

The LUCID project will follow the commonly accepted tests for soil productivity (chemical and physical analyses and erosion indicators) and, by sampling quadrats with different land use histories but similar biophysical characteristics, “substitute space for time” to estimate the impact of land use on soil properties. In addition, farmer perceptions will provide valuable information on changing agricultural productivity of the soil, and the causes of those changes. Where available, other information such as government statistics of changing yields will be considered. Finally, by analysing satellite images, we will determine the change in potential “productivity” of the land for natural flora and fauna by measuring habitat fragmentation, wildlife corridors, access to water sources, etc.

The indicators of land degradation presented below are based on what was perceived as possible in the LUCID 2001 workshop given our project objectives, expertise within research teams, financial resources available and the time to complete the activities. While we concentrate on assessing land degradation based on our definition, and the rather limited sets of observations, it is important to bear in mind the broader context of land degradation that would embrace other factors that we will not be measuring in the LUCID project. This is important because some of these factors that we will not be measuring might be directly or indirectly influencing the parameters we will measure. For example we will not be measuring beneath ground soil biodiversity but it is known that microbial organisms in the soil may influence not only the chemical composition of the soil but also the physical properties and thus the vegetation as well. Ground water is another example of non-LUCID measured parameter may influence vegetation. Being aware of these factors and taking note of field observations that may suggest such influences will be very important, especially when doing cross-site comparisons.

At the field level indicators for land degradation that we will be measuring can be categorized into an onsite and offsite indicators.

Onsite indicators of land degradation

- Soil erosion
- Deterioration of:
- Physical properties of soil (texture)
- Chemical properties of soil (nutrients, carbon, etc.)
- Vegetation
- Plant indicators of degraded soils
- Stakeholder perceptions on changes in soil productivity and other soil characteristics

Offsite indicators of land degradation

- Siltation: This is important and may be easily detected in the field as alluvial deposits in river catchments or recent sedimentation of soil materials deposited by either surface runoff or wind.
- Pollution of reservoirs: This will be measured in Kenya Kilimanjaro site where water pollution by farming systems will be studied.

C. DATA COLLECTION METHODS

C.1. Introduction

This section will describe methods of how new primary field data required for each site will be collected. Data to be collected should be additional to the previously existing data and information, so harmonization in collection locations and approaches will assist in integrating data during the analysis phase.

The purpose of this new data collection is to ensure that there exists data that is comparable across sites. In addition, it will result in data on the three major factors of our study (land use, biodiversity and land degradation) collected in the same locations, so that relationships between the three can be statistically analysed.

Perhaps the most critical aspect of field data collection is the sampling framework for locating the transect quadrats. In order to determine the impact of land use change on biodiversity and land degradation, what is required are sample quadrats with similar biophysical factors (elevation, rainfall, soils), so that natural vegetation is similar, but with varying land uses. This variation in land uses will provide our “substitution of space for time.” We are assuming, for example, that the land in the past was in a more natural state (e.g., bush), and has since then become more intensely used (cleared for crops). Areas under bush today have similar vegetation and soil characteristics as areas currently under crops would have supported, if they had not been cleared. The impact of the clearance on vegetation and soils can then be estimated. The information to be collected in the transect quadrats, therefore, includes vegetation, soil characteristics, indicators of soil degradation and soil erosion, and land use histories.

In addition, information will be collected on land use and environmental changes that does not depend on the “substitution of space for time” approach. This information will be obtained from local people and from whatever statistical or other sources are available. Primary data collection methods include key informant interviews (e.g., of beekeepers and herbalists) concerning changing natural vegetation, group interviews concerning patterns and causes of land use change, and surveys/ questionnaires of perceptions of soil degradation and links to land use and soil management changes. Below is a summary table of the information to be collected and methods of collection (Table 1), followed by a generic chronology of data collection activities (Box 1).

Table 1. Types of Information and Data Collection Methods

	Data collection methods				
	Surveys/ Interviews			Transect (Quadrat)	GIS analysis
	Surveys	*Group Interviews*	*Key Informant interviews*		
Land use/cover change (LUCC)	**X**	**X**	**X**	**X**	**X**
LUCC driving forces	**X**	**X**	**X**		**X**
Ecosystem Diversity				**X**	**X**
Ecosystem Distribution			**X**		X
Perceptions of soil	**X**	X	**X**		
Plant indicators of soil deg.			**X**	**X**	
Soil erosion estimates	X			X	
Soil chemical and texture				X	
Plant spp. diversity			X	X	
Wild fauna diversity				X	

Box 1. Chronology of Field Research

1. Sampling frame for transect completed: transect chosen, random sample points for the subtransects within each AEZ chosen, identification of land use types in each subtransect made and two quadrats on each of them stidied. Location of more detailed sampling site (e.g., in a semi-arid area) chosen
2. Indicator plants of changes in soil fertility determined during group interviews with key informants (elders, people who know the area well) in each AEZ. Results will be used in transect survey.
3. Conduct transect survey: need someone with expertise in vegetation who can identify plant species, someone to examine soil erosion indicators; need GPS, soil sampling and other equipment
4. Group interviews with beekeepers and herbalists or other experts in local flora concerning changes in wild plant biodiversity and reasons for those changes, using guide and interview sheet
5. Group interviews with farmers and herders in various locations (esp. where the transects or other surveys have been done). Some of these questions might be more effectively addressed if people are stratified by age, gender or ethnic group.
   a. land use changes, and their root causes
   b. opinions of impact of those changes on soil fertility, and on plant and animal biodiversity
   c. opinions of future LUC, soil and biodiversity changes (in 10, 20 years)
6. Household and field level surveys of farmers and herders on changing land use and soil management on their land; changing soil properties on their fields, and household characteristics including economic activities and labor availability.
7. Depending on particular site: wildlife counts, bird counts, water quality analyses…
8. Feedback workshops and seminars after field research and land use change preliminary analyses completed—with farmers and herders, and with decision makers
   a. present and verify results, discuss interpretation of the results
   b. discuss implications re land management, policy

C.3. Selection of Sites for Field Data Collection

The selection of the general area for new data collection should be based on the following principles.

1. Where the team is already working and has existing data (land use/cover and other data). As much as possible we should keep to the sites where we already have data so that any other data collected will be additional to the existing.
2. Along the ecological gradient. As to the overall objectives of the project and the general design of the four working sites data will be collected along an ecological gradient across agricultural ecological zones (AEZ) and on different land use / land cover types in each ecological zone. In most of the sites, the gradient will cross elevation zones.
3. Selection of transect locations: the location of one or more transects crossing the ecological gradient should be selected to represent typical ecological characteristics and land uses of the area.
4. Along the transect, four sub-transects chosen randomly will contain the vegetation/soil quadrats.

C.4. Use of Plants as Indicators of Soil Degradation

The reason for using wild plants as indicators of changes in soil fertility, or soil degradation is because plants are sensitive to soil conditions, and because farmers are knowledgeable of which wild plants indicate good or bad soil fertility. Use of plant indicators will be one of our best methods of determining soil fertility and changes in the soil due to land use change, because we will not have historical soil testing data to compare with our new soil analyses. We will use plant indicators during the transect work. In each quadrat, we will determine whether any indicator plants are growing in the quadrat, and identify them.

The plant indicators will vary across agro-ecological zones, due to differences in growing conditions. We will need, therefore, to determine the plant indicators for each zone across the transect. Similarly, the indicators will probably differ between research sites, for example between the Kenya and Tanzanian sides of Mt. Kilimanjaro.

Therefore, we first need to learn from knowledgeable local people what are the plants that indicate good or bad soil fertility or changes in soil fertility (Box 2). The older people, especially those who in the past chose what land to crop each year (before land privatisation), are probably the most knowledgeable about wild plants and plant indicators. It is best to have a group of around 10 people to discuss among themselves what plants are the best indicators, because of differences of opinion and experiences. The same plant may be cited by different people as indicating improving and declining fertility, so it is best to have a group discuss which plants are best for the team to use.

In arranging the group meeting, therefore, request to speak to people knowledgeable about cropping, soils, and wild plants. Present to the group the purpose of the research (to understand the linkages between land use change and changes in the soil), what field methods will be used and where, and how their answers will be important during the research. Since this meeting will occur before the transect work, it may be a good opportunity to introduce the project to elders and leaders of the community.

Record comments that may affect how we interpret the presence of the indicator plants (e.g., is there a difference between plants that indicate poor soil, and those that indicate deteriorating soil? Is the plant more prevalent in a particular type of soil?).

Note also the various names of the plants, and try to determine whether the name they use is for a general type of plant, or several species. If possible, gather a sample of the plant to determine its botanical name.

Let the group know that you will be returning to them after the transect and other work, to share with them the results of that work and to discuss more specific issues about why land use has changed, why soil fertility has changed, and why wild plants have changed.

Box 2. Guide to Interviews on Identifying Plant Indicators

1. Has soil fertility changed during the past 20 years?
2. a. What wild plants (weeds) appear in cropped fields that indicate that soil fertility is poor? Or that soil fertility has declined?

   b. What are the best 3-5 plants that we could use that show that soil fertility has declined? What are their particular characteristics (e.g., grows where over cultivated, or grows on rocky soil). Be sure to identify the botanical name and/or collect samples of the plants.
3. a. What wild plants (weeds) appear in cropped fields that indicate that soil fertility is good? Or that fertility has improved? Be sure to identify the botanical name and/or collect samples of the plants.

   b. What are the best 3-5 plants that we could use that show that soil fertility has improved? What are their particular characteristics (e.g., appears after apply manure, or grows on red soil, etc.) Be sure to identify the botanical name and/or collect samples of the plants.
4. a. What wild plants appear in pasture lands that indicate that the quality of pasture is bad? Or that it has deteriorated?

   b. What are the best 3 plants that we could use that show that pasture quality has declined? What are their particular characteristics (e.g., shows overgrazing, is unpalatable, annual vs. perennial grasses, etc.)
5. a. What wild plants that appear in pasture lands that indicate that the quality of pasture is good? Or that indicate that it has improved?

   b. What are the best 3 plants that we could use that show that pasture quality has improved? What are their particular characteristics (e.g., shows overgrazing, etc.)

C.5. Data Collection along Transects

The purpose of the transects is to provide primary data on biodiversity, soil characteristics and land use/land cover collected in the same locations using a systematic sampling frame. Statistical analysis of the data will thus permit identification of the relationship (causal or otherwise) between these three factors. It is important that each site collect this data using similar methods in order to permit comparison of the data between sites; small variations in data collection methods often leads to data incomparability.

C.5.a. Transect and Quadrat Sampling Framework

Each site will be covered by one or more transect lines traversing the ecological gradient of the study site. The transects will be selected from topographic sheet and/or other spatial information to provide a representation of AEZ's and land use types.

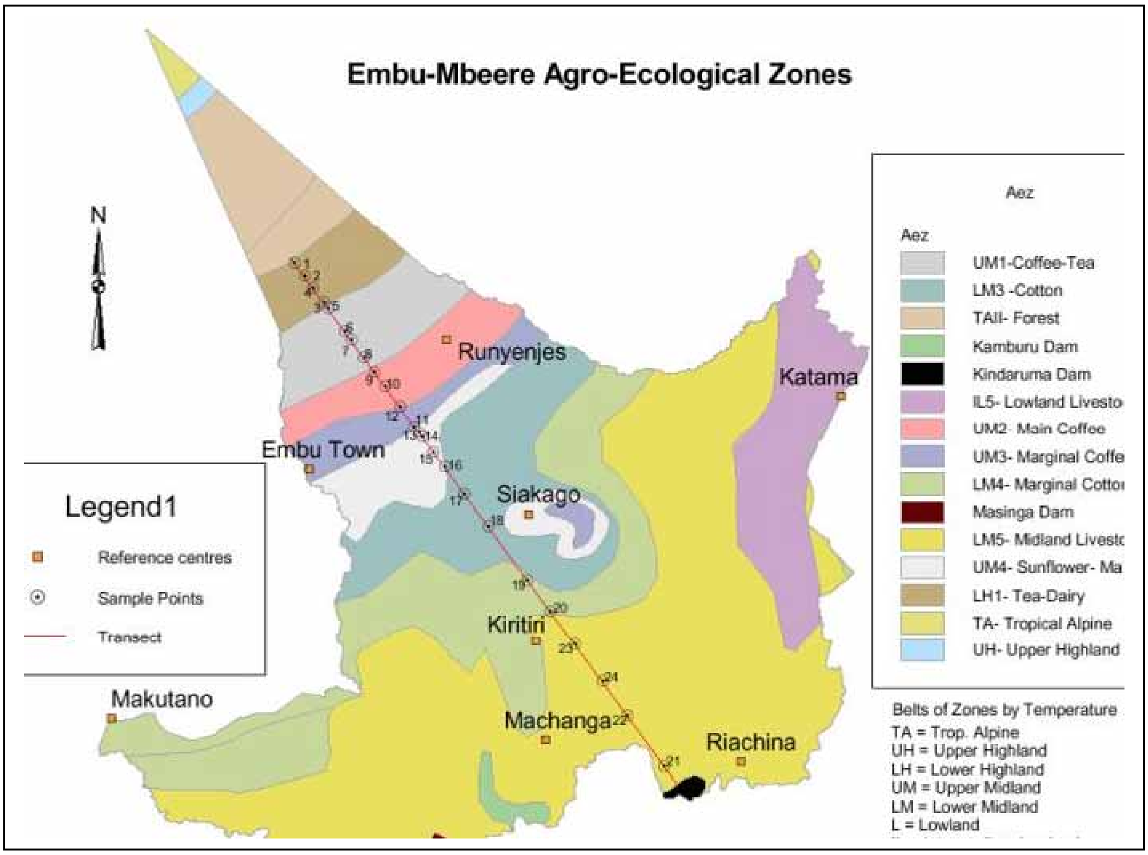

Figure 1. Map of Transect Location and AEZ in Embu/ Mbeere Districts, Kenya

In a case where a prominent land use type in the AEZ is not well represented in the sub-transect, sampling can be made on the plot nearest to the sub-transect. The stratification will be done according to agro-ecological zones (AEZ. The AEZ's are based on seasonal precipitation, temperature and soil type. In most of the LUCID study sites, the AEZ's parallel the elevation gradient, due to the strong orographic influence on rainfall and temperature.

The stratification by AEZ will control for these biophysical factors, while land use and land cover will vary. The following land cover classes have been suggested for stratification to ensure the variety of land uses and covers:

1. Coffee or tea dominant
2. Currently cropped with seasonal crops
3. Riveraine, marsh or swamp vegetation
4. Edge types – roads and field boundaries
5. Grassland – areas with open grasslands or at least 75% covered with open grasslands
6. Fallow - areas about 1-5 years without cultivation
7. Bush – areas containing thickets approximately 2-5m that have never been cultivated. Also see Bushland in the physiognomic vegetation description below.
8. Planted trees, woodlots
9. Natural vegetation – see physiognomic description of vegetation in Box 3.

In the semi-arid zones, a more extensive sampling can be made with more quadrats to provide a more complete picture of the impact of recent land use changes on biodiversity and land degradation (Helen mentioned possibility of purposive sampling). In all LUCID sites, the higher rainfall, cooler AEZ's are characterised by a long history of high population densities and intensive cropping. Clearance of natural vegetation occurred many years ago, in most cases over 50 years ago. The semi-arid areas, in contrast, are in the process of experiencing a land use transition from more natural vegetation, often grasslands used for grazing, to permanent cropping, and more opportunities exist for the project teams to examine first hand the relationship between land use change and change in biodiversity and land degradation. The areas undergoing this transition, therefore, will receive more focus and a higher density of sample points.

In the semi-arid zones, more sample points will be chosen within the same AEZ, attempting to control for climate, soil and topography but with varying land uses. For example, within the semi-arid AEZ of particular interest, a large block with similar soil, climate and topography should be delimited. Within that area, sampling should be done at random, ensuring that the major land use classes are represented by at least 10 quadrats The number of sampling points will be determined by the number of land use classes on the sub-transect. The more the land use classes per sub-transect the more the quadrats to a minimum of two quadrats per land use class.

For each quadrat, data will be collected on its location, characterisation of the site and land use, as well as measurements of vegetation and soil characteristics.

C.5.b. General Information Collection

The blocks and the quadrats are located in the field using a map, and a GPS. For each quadrat, the following general information will be recorded on the field sheets:

1. Location
   The location of the sampling point determined by GPS readings, and marked on a topographic map or other paper map.
2. Land cover, landscape
   Land cover described and classified according to the classification developed for Africover project. Land cover classes to be applied are presented in the section outlining vegetation and land cover classifications. The position on the landscape (e.g., aspect on hillside) will be described.
3. Land use
   According to class, the following information will be recorded:
   a. Cultivated land; the 3 major crops ranked as primary, secondary and tertiary by estimation. Also, an estimate of what year the field was put under cultivation (when converted from bush or other previous land use), information obtained from local people.
   b. Fallow; include information on duration of fallow and whether it is being grazed. This data can be obtained from local people. When people are unavailable or do not know, the field team can estimate whether it is being grazed.
   c. Trees: species and placement (woodlot, scattered trees, tree lines).
   d. Bush, woodland, or field or road boundary, and whether it was being grazed.
4. Land use history
   If the owner or knowledgeable person is available, determine what year the land was put under its current use, what the previous land use / land cover was, and the year it was put under that cover (i.e., record a land use/ cover history).
5. Ownership
   a. Name of the owner. The full name is not required, only a name that enables the team to distinguish between different landowners among the sample points.
   b. Walking distance in minutes from the field point to the owner's homestead, to be acquired from local people.

C.5.c. Vegetation

Usually, quadrats are square and their main purpose is to establish a standard area for counting the number of plants per species. Quadrat sizes vary from one type of vegetation to another (Kent and Cooker, 1992). For purposes of convenience especially in inter site comparisons we should adapt uniform quadrat sizes for similar vegetation categories in all the sites. We recommend quadrat sizes presented below to be applied to all sites.

In determining the sizes of quadrats to sample in cropped fields, the crops themselves can be categorized as herbs, shrubs, trees, or tall or short grasses. If a particular crop can fit well in these classes the height of the crop above ground can give a crew on the quadrat size. Crops with 0.2m or less can be sampled with 0.5x0.5m; those with a height between 0.2 and 2m can be measured with 1m x1m – 4m x 4m. Crops with height between 2m to 8m can be measured using 10m x 10m quadrats. Those above 8m in height can be measured using 20m x 20m - 50m x 50m quadrats.

Table 2. Quadrat size by vegetation type

Vegetation type	Quadrat size
Bryophyte and Lichen	0.5m x 0.5m
Grasslands, short grasses	1m x 1m - 2m x 2m
Shrubby heaths, tall herbs and grasses	2m x 2m - 4m x 4m
Scrub, woodland shrubs	10m x 10m
Forest Woodland canopies	20m x 20m – 50m x 50m

A conventional square quadrat (Figure 2) usually has a wooded or metal frame and often subdivided into equal lengths usually ten (but sometimes two or four) with strings or wires to increase accuracy of estimating when using certain measures of abundance like percentage canopy cover, since each sub unit of the quadrat can be examined separately.

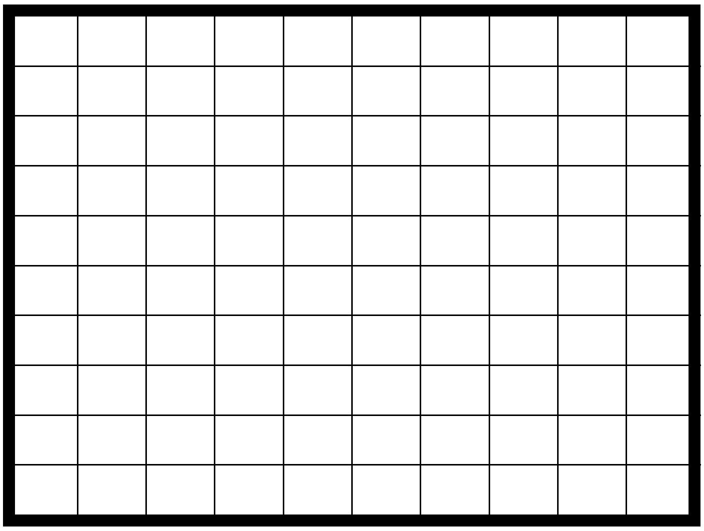

Figure 2. A Conventional Square Quadrat with 10 Subdivisions

1. Species names:
In each quadrat all species present will be identified in botanical name and recorded in the vegetation field data sheet provided in the Appendix I. As much as possible plants whose local names can be obtained should also be recorded in the data sheet.

2. Species counts:
Vegetation studies using quadrats will provide data on the counts of individual plants of every species found in the quadrat. For some vegetation types the number of individual plants per species may be too numerous to count in the whole quadrat like fore example some weeds that may cover the whole quadrat. In such cases a quadrat with ten subdivisions can be used to show the counts in one subdivision from which a computation for the whole quadrat can be made.

3. Species percentage canopy cover:

We will also collect information on percentage canopy cover per species within the quadrats. This will be done by visual examination of the proportion of the space covered by each species and expressing it as percentage of the total area of the quadrat.

4. Plant Indicators
Identify whether any of the plant indicators of changing soil fertility or pasture quality are present in the quadrat (see Section C4 for discussion of plant indicators). If so, record the number of individual species in the quadrat.

Box 3. Guide to Vegetation Classes

For the natural vegetation, a physiognomic description of vegetation types is presented to assist in differentiating natural vegetation outside of the cultivated areas. The following physiognomic vegetation description is adapted from field methods for vegetation mapping 1994, prepared by the Nature Conservancy Nature conservancy 1994. The relative percent cover of the tree, shrub, dwarf shrub, herbaceous, and non-vascular strata defines formation classes.

- FOREST - Trees usually over 5m tall with crowns interlocking (generally forming 60-100% cover). Shrubs, herbs, and non-vascular plants may be present with any cover value.
- WOODLAND - Open stands of trees usually over 5m tall with crowns not usually touching (generally forming 25-60% cover). Shrubs, herbs, and nonvascular plants may be present with any cover value.
- SPARSE WOODLAND - Trees usually over 5m tall with widely spaced crowns (generally forming 10-25% canopy cover). Shrubs herbs and non-vascular plants may be present with any cover value.
- BUSH - Shrubs and or small trees usually 0.5-5.0 meters tall with individuals or clumps not touching or interlocking (generally forming > 25% canopy cover). Trees may be present, but with cover 10% percent or less. Herbs and non-vascular plants may be present at any cover value.
- SPARSE BUSH - Shrubs and/ or small trees usually 0.5-5m tall with individuals or clumps widely spaced (generally forming 10-25% canopy cover). Trees may be present, but with cover 10% percent or less. Herbs and non-vascular plants may be present at any cover value.
- DWARF BUSH– Low growing shrubs and/ or dwarf trees usually under 0.5m tall (though known dwarf forms between 0.5 –1.0m can be included), with individuals or clumps not touching to interlocking (generally forming >25% cover). Trees and shrubs greater than 0.5m may be present, but with canopy cover 10% or less. Herbs and non-vascular plants may be present at any cover value.
- SPARSE DWARF BUSH- Low growing shrubs and/ or dwarf trees usually under 0.5m (though known dwarf forms between 0.5 –1.0m can be included), with individuals or clumps widely spaced (generally with 10-25% cover). Trees and shrubs greater than 0.5m may be present, but with cover 10% or less. Herbs and non-vascular plants may be present at any cover value.
- HERBACEOUS – Graminoids and /or forbs (including ferns) generally forming >10% cover. Trees, shrubs, and dwarf shrubs may be present, but with cover 10% or less. Non-vascular plants may be present at any cover value.
- SPARSE VASCULAR VEGETATION/ NON-VASCULAR – Vascular vegetation is scattered or nearly absent. The cover of each vascular life form (tree, shrub, dwarf shrub, herb) is at most 10 percent. Cover of non-vascular plants (mosses and lichens) may be absent to continuous.

Strata/Life Form, Height, Cover, Diagnostic Species
Visually divide the community into vegetation layers (strata). Indicate the average height of the stratum and the average percent cover of the whole stratum. Trees are defined as single-stemmed woody plants, generally 5m in height or greater at maturity and under optimal growing conditions. Shrubs are defined as multiple stemmed woody plants generally less than 5m in height at maturity and under optimal growing conditions.

C.5.d. Soils
Soils will be studied in all agro-ecological zones, also along the transects. The purpose of the soil studies is to have data from the same locations as the vegetation and land use data, to estimate the impact of changes in vegetation and land use on soil properties.

We will use standard soil erosion field record sheets provided in Appendix VI to assess soil erosion parameters, and collect soil samples to gather data on physical and chemical properties. Due to the limited funds for soil laboratory analyses, not all samples collected will be analysed but soil samples should be collected from every land use type in each sub-transect. Laboratory analysis of soil samples will be as per land use types in the agroecological zones. If need be and funds permit, analysis will extend to similar land use types in different sub-transects. It is necessary to have all the soil samples analysed at the same laboratory to allow cross-site comparisons of the results because results of different laboratories tend to vary greatly. The project will be using the soil laboratory at ICRAF in Nairobi for homogeneity of results, and to permit comparisons with other CG and GEF research project soil sampling results.

Use the following approach to collect soil samples:

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1. Use a soil auger with clean sampling head made of stainless steel.

2. Do a "zigzag" around the field to collect soil from various places in the field. Avoid field borders, ditch banks, old brush piles, burn sites, ant mounts, mice burrows, etc.

3. Samples will be collected using soil augers at 0-10, 10-20cm depths. From each of the two depths collect sub-samples of the auger sample and mix well in a plastic bucket

4. If the soil is too wet to till, it is best to wait for drier conditions before taking samples. Wet soils do not mix thoroughly and may affect the quality of the sample taken.

5. Thoroughly mix the sub-samples in the bucket. Break up clumps and remove any large particles of trash. Place at least 200g of thoroughly mixed sample into a polyethylene bag, and seal the bag properly. On each bag attach a label showing GPS location, transect name, site name, and the quadrat number.

6. Soil samples should be air dried thoroughly by spreading out the soil on a surface such as cement bags in the shade. Return the soil to dry, labelled bags and store the bags in dry conditions until they are transported to the lab for analysis.

Record the soil type and physical characteristics, as follows:

1. Name of the soil in the local language.

2. Erosion estimates based on selected indicators (including crusting and hardsetting, bare, quartz layer on surface). See Appendix VI for field assessment sheets.

3. Physical characteristics of the sampling site. The slope and length of the field, location and aspect on the hillside, and presence of soil conservation techniques.

C.6. Survey of Birds

The most commonly used method in East Africa for estimating birds species number and composition in an area is the Timed Species-count (TSC) described by Pomeroy and Tengecho, 1986a, 1986b; Pomeroy, 1991. This technique can be used to compare the bird faunas across a series of sites.

It is first necessary to define particular sites where counts will be made. This description should be made according to the land cover classes presented above. As for other studies birds should be counted within the 500m sub-transects described above.

A timed species-count consists simply of a species list, in which all species positively identified are listed, in the order of observation. Bird counts are made within a period of one hour. It is important to ensure that all counts are made within same time lengths to enable comparison between sites.

To make the count, one moves slowly around the study site, listing any species which are anywhere within it, regardless of how far away. Species flying over are included if they are using the site, for instant swallows feeding, kites looking for food or raptors displaying. Vegetation on which birds are found should be noted according the classes provided. Please refer to Pomeroy 1991 for details on field methods of counting birds and data presentation.

Repeat sampling at the same site at variable times of the day and at different seasons is usually done to reduce bias on the types of birds counted.

C.7. Water analysis and wild life surveys

Sites planning to conduct water analysis and wildlife surveys are Mt. Kilimanjaro in Tanzania., and Loitokitok in Kenya. In both cases, water will be sampled in different land uses to test for physical and chemical characteristics. The purpose is to investigate the effects of different land use practices on water quality. In river systems, water will be sampled upstream before the land use type under investigation and downstream presumably after. Where applicable the samples should be taken in a series including samples upstream, downstream and in between or within land use area.

The parameters to be tested are the standard water chemical analysis, including those commonly found in farm inputs and livestock disease vectors. These analysis are expected to link up with soil analysis so that chemical exchange between water, soils and farm management practices can be investigated.

C.8. Expert Accounts of Changing Natural Vegetation/ Floral Biodiversity

Although the land use change analysis using air photos and satellite imagery will provide a gross indication of changing amounts of land under different land cover classes, only ground level data will provide information on the loss or increase of individual species. As we discussed during the workshop, a good source of information on changing wild plant species in an area would be beekeepers because they are very dependent on wild sources of pollen and nectar. A second good source of information would be herbalists (people who use wild plants for medicinal purposes)[1]. These two groups of local experts can thus provide detailed information on particular plant species, and we can interpret their information in terms of changes in the ecosystems.

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[1] A word of caution on interviewing herbalists: they may be unwilling to share their trade secrets (what plant to use for what malady), so don't pressure them for details. Try to get them to discuss what plants they collected in the past are now disappearing, and why. If they are still unwilling, don't push.

Box 4. Guide to Key Informant Interviews on Plant Biodiversity (beekeepers, herbalists)

1. What are the general changes that you have noticed over the past 20/10/5 years in availability of plants for your bees/ medicines?
   a. What general changes have occurred
   b. What plants have become scarce—note individual plants, and groups of plants (e.g., bushes, trees, herbs)
   c. Where did they used to be found? Note types of landscapes, and specific locations
2. When did the decline occur?
3. What are the causes of the changes?
4. Have the changes affected your ability to produce honey / provide medicines? How?
5. Complete the "Framework for Interviews", Appendix 1

To best capture this knowledge, bring together a small group of beekeepers and herbalists (separately) to discuss the situation. This approach often brings much better results than individual interviews and is faster for the interviewer. Two types of questions should be asked: general questions about the situation (see guide below), and specific questions on plant species that are disappearing—see Appendix II for "Framework for Interviews on Changing Plant Biodiversity". The "Framework" is based on a study being done in Sango Bay, Uganda on changing biodiversity. The sheet produces data that can be quantitatively compared between sites.

C.9. Perceptions of Soil Degradation

Due to the lack of baseline data from soil samples, the best available information on changing soil characteristics in our sites comes from the farmers and herders themselves. An important advantage of seeking this information from the farmers and herders is that their land and soil management is what is affecting the soil, and they can provide information on those practices and how they perceive them to be affecting the soil. They are also, of course, very aware of, and conversant with, changing soil productivity on their land.

There are two possibilities for obtaining this information—using informal group interviews, or a survey with questionnaire. It is not required in the LUCID project that each team conduct a survey, but advantages of the survey approach include a) obtaining data on changing soil characteristics, management practices and land use histories for many specific fields, b) obtaining data on household characteristics that affect soil management and perhaps affect soil fertility, and c) the ability to statistically analyse the results. Indeed, soil degradation perception data from previous surveys have shown that statistically valid comparisons in soil degradation severity can be made between regions, groups of farmers, and especially field management practices. Answers may be obtained to research questions such a "what is the poverty/ degradation relationship" or "what are the major management factors preventing soil degradation?"

Sample questionnaires are provided in Appendix III and IV. They originate from questionnaires that were used in Rwanda, Embu/Mbeere in Kenya, and Kabale in Uganda so that use of the questionnaires would provide cross-site comparability with those sites. The questionnaires are at two levels: the household and the field. The household questionnaire is completed in each household, whereas the field level questionnaire is completed in several fields, for example 3 fields, of each household. After completing the household questionnaire, therefore, one walks to three separate fields of that family and completes three field questionnaires. The choice of the fields depends on what variability is important to capture. Often, the distance from the home to the field greatly affects how the field is used, so a choice

Box 5. Guide for Group Interviews on Perceptions of Soil Degradation

1. Has the soil productivity of this area been changing (both improving and deteriorating)?
2. How severe is the change?
3. Where is it changing (both improving and deteriorating), and where is it not changing?
   - Certain areas, certain land uses (e.g., grazing vs. cropped areas)
   - Location on the hillside
   - Distance from people's homes
4. When: What has been the trend during the past 30/20/10/5 years?
5. Why has the productivity been changing?
   - Changes in:
     -soil inputs (manure, fertilizer, compost, crop residues, etc.)
     -soil management techniques
     -soil conservation practices
     -crops grown
     -use of fallow
     -what is the cause of those changes
   - Over cultivation, or erosion, and why
   - Changes in farm or family characteristics: e.g., farm size, labour availability
   - Changes in land use / cover in the region affecting inputs, erosion, etc.
6. Are there differences between families in soil degradation? Is there a difference between rich and poor people? Why?
7. Have there been external factors affecting soil management?
   - Government/NGO programs
   - Land tenure changes
   - Factors affecting availability of inputs, etc.

might be to survey one field near the home, one at a medium distance and one far away. Try to get a good variation in types of fields. The questions that will be most useful from a cross-site comparison perspective would be, at the household level, table 15 (modified to include the most common soil management techniques), and at the field level questions 2, 3, 5-8, 10, 11, 14, 16 and 17.

To be statistically valid, sufficient numbers of households must be surveyed to represent the area. A common rule of thumb is that at least 30-35 cases are required in each category to provide statistically valid results.

The second method of gathering information on perceptions of soil degradation is by using group interviews. Different types of information from that of surveys are obtained. Rather than data and information about the impact of management practices or household characteristics on soil properties on specific fields, general information about trends in soil productivity of the region, or the impact of external factors (such as government programs or change in availability of manure), may be obtained. Indeed, ideally both methods, surveys and group interviews, are used. Depending upon the location, best results may be obtained by conducting interviews of groups separated by gender, age group or ethnic background. The choice of questions should be guided by the researcher's hypotheses, and for the LUCID's project, linked to changes in land use, land and soil management, and changes in vegetative or animal diversity.

C.10. The Driving Forces of Land Use Change

Information on the root causes, or driving forces, of land use change will come from many different sources, including analyses of policies and programmes, demographics, economic factors, etc. Some critical information may also be obtained from interviews with local people concerning their impressions of the patterns of land use changes that have occurred, and the reasons behind those changes. Information that they might provide that would not be available from national level sources or statistics include the impact of local individuals or institutions (e.g., a large ranch or school), the impact of household level economies (e.g., for investment in irrigation), how the local socio-political context has affected land use, the existence of land use conflict, and what the trends are for future land use change.

These interviews are best conducted after remote sensing data is interpreted and initial land use change analyses are available, if possible. With maps of land use/ cover, the researcher can ask about specific nearby localities—why certain areas changed and others didn't, etc. As with other group interviews, best results may be obtained by interviewing groups separated by gender, age group or ethnic/economic background. The questions asked during the group interview should be guided by the researchers' hypotheses concerning local to national level driving forces, and by the results of the remote sensing analysis. Below is an outline of basic questions.

Box 6. Guide to Group Interviews on Driving Forces of Land Use Change

1. What are the major land use changes that have occurred in this area since the 1950's? Examples might include:
    - Grazing to crops
    - Seasonal crops to horticultural crops, irrigation
    - Small scale agriculture to large scale agriculture
    - Declining farm sizes
    - Fencing
    - Clearance of woodlands, bush or forest for crops
    - Planting of trees
    - Expansion of built up areas
2. Where did the change occur, and why in those particular localities?
3. When did those changes occur, and why then?
4. Who is responsible for those changes?
    - New generations of local people (role of local population increase)
    - In-migration by other people (who, why, when)
    - Outside or local investors
5. Has this led to conflict over land, water or other resources?
6. What are the big reasons for these changes in land use?
7. What has been the role of the changing national economy in affecting land use?
    - Changing demand/ markets for commodities
8. What has been the role of the national government in affecting land use?
    - Land tenure (adjudication, privatisation, sub-division, etc.)
    - Infrastructure development/ deterioration
    - Agricultural programmes
    - Enforcing, or not enforcing, rules such as park boundaries
    - War/ peace
9. What has been the role of the local government? of NGO's?
10. What will this area look like in 10 years? 20 years? What are the forces affecting future land use? Good way to get at this is to ask "What do you think the future will be for your children?"

C.11. Feedback Workshops

The purpose of feedback workshops is threefold: 1) to return to the community useful information that has been gathered by the project, 2) to identify and have the community consider policy and other implications of the information, and 3) to help ensure that the researchers are correctly interpreting the data and information that they have gathered.

The feedback workshops are thus usually held after the data has been collected, preliminary analyses completed, and initial conclusions developed. For the LUCID project, the workshops would probably be held during year 2. In some areas, such as in the Amboseli area of Kenya, feedback workshops are requested by the communities and are a condition of allowing the researchers access to the area. The workshops are usually open and participants include farmers and herders of the area, especially those who participated in the research, local community leaders and perhaps local government, NGO or other representatives.

The researchers present results from their research that would be of particular interest to the group. Maps, graphs and other visual aids can be used to good effect. Examples of analyses that might be useful to the group would be maps of land use change, survey results comparing regions or groups, summary trends, or a focus on a particular problem facing the area (e.g., soil degradation, shortage of water resources). In addition to presenting data, the researcher can present initial conclusions on the reasons behind the trends in the form of questions. This would then start the discussion. Discussion can then be directed towards the implications of the results concerning particular issues facing the community. An approach for this type of community participatory development is based on Freire. Copies of a working paper describing this approach will be distributed to LUCID teams.

D. REFERENCES

Ibrahim and Kabuye, C. S., 1987. An illustrated manual of Kenya Grasses. FAO Rome. 765 pp.

Kent, M. and Cooker. P. 1992. Vegetation description and analysis: a practical approach. Belhaven Press. London.

Lal, R., B.A. Stewart (eds.). 1995. Soil Management: Experimental Basis for Sustainability and Environmental Quality. Advances in Soil Science. CRC Press: Boca Raton, FL USA.

Lal, R., W.H. Blum, C. Valentine and B.A. Stewart (eds.). 1998. Methods for Assessment of Soil Degradation. Advances in Soil Science. CRC Press: Boca Raton, FL USA.

Ministry of Agriculture and the German Agricultural Team. 1982. Farm Management Handbook of Kenya. Ministry of Agriculture, Government of Kenya.

Nature Conservancy 1994. Field Methods for vegetation mapping. NBS/NPS Vegetation Mapping Program. Environmental Systems Research Institute, Inc.

Perkins J.S. 1999. Developing a methodology for a community Natural Resources Inventory and Monitoring System. Department of Environmental Science, University of Botswana. For USAID/NRMP.

Pomeroy, D. 1991. Counting birds. African wildlife book series number 6. African Wildlife Foundation, Nairobi Kenya.

Pomeroy, D. and B. Tengecho, 1986a. Studies of birds in a semi-arid area of Kenya. III The use of Timed Species-counts for studying regional avifaunas. Journal of Tropical Ecology 2:231-247.

Pomeroy, D. and B. Tengecho, 1986b. A method of analysing birds distribution. African Journal of Ecology 24:243-253.

Southwood, T.R.E. 1978. Ecological methods: with particular reference to insect populations. The Language Book Society and Chapman and Hall. (ELBS) pp 247.

Stockings and Murnaghan 2000. Land degradation guidelines for field assessment. UNU/UNEP/PLEC Working Paper. Overseas Development Group, University of East Anglia.

Tiffen, Mary, Michael Mortimore and Francis Gichuki. 1994. More People, Less Erosion: Environmental Recovery in Kenya. John Wiley and Sons: New York.

Wilson C.J. Reid, R.S. Stanton, N.L. and Perry, B.D. Effects of Land Use and Tsetse Fly Control on Bird Species Richness in Southwestern Ethiopia. Conservation Biology 11, 2: 435-447.

Figure 3. Conceptual Framework for Investigating Land Degradation using Plant Indicators

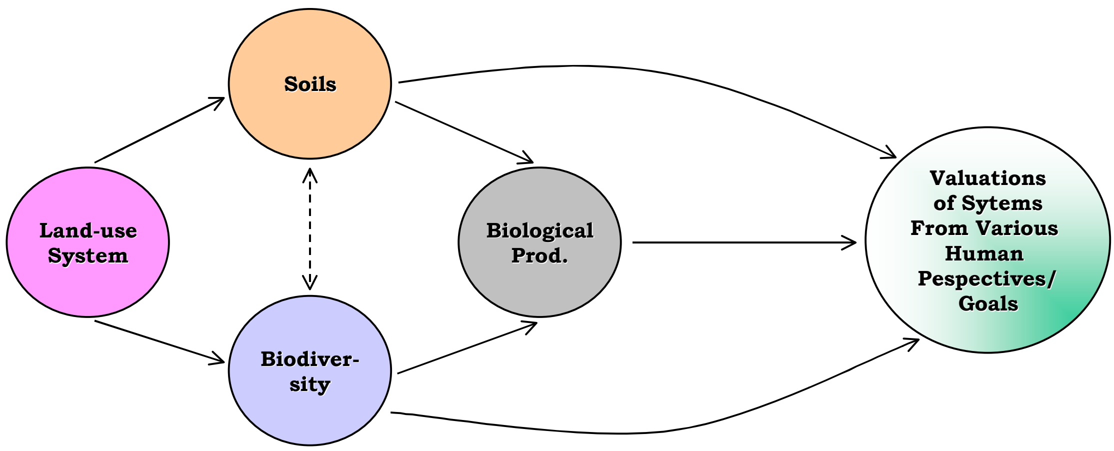

Figure 4. Stages In Analysis to Identify Land Use/ Land Degradation Linkages

STAGE 1

Field analysis of land use systems in respect to:

- crop types
- land management
- land use history
- driving forces

STAGE 2a

Soil analysis in respect to:

- Type
- Erosion
- Physical and chemical properties
- Soil fertility indicator plants

STAGE 2b

Biodiversity surveys in respect to:

- Vegetation structure, and composition.
- Biodiversity of selected organism or organisms.
- Farmers perceptions of ecosystems changes and availability of key resources.

STAGE 3

Determination of degradation from trends in the processes analysed in stage 2 as they reflect upon stage 1 in relation to:

- Biological productivity
- Human perspectives and goals
- Socio-economics

APPENDIX I: Vegetation Surveys Field Data Sheets

Sheet #1

Date………………….
Surveyors:
Name of LUCID site……………………Transect Name……………………………
AEZ …………………   GPS Coordinates:……………………...
Quadrat No:……………
Division……………………Location…….…………… Sub location…….…………
Farmer/ Land Owner's Name:………………………… …

General:
Position on hillside: Upslope (   ) Mid slope (   ) Down slope (   ) No Slope (   )

Slope of field: ………..degrees

Length of field: ………..meters

Aspect on hillside: …………….(facing north/south/east/west)

Land Cover type …………………

Land Use (describe): ………….

If cultivated, 3 most common crops ranked by importance:

1………..
2…………
3. ……….

If fallow, years since cultivated: ……years

If trees present, placement of trees: woodlot ( ), scattered ( ), tree lines ( )

Grazing: is the land being grazed? Yes, heavily ( ) Yes, lightly ( ) No ( ) Don't know ( )

Land use history:
Year that field was put under current land use: …....year
How was the land used previous to its current use? ………………previous land use
Year that it was put under previous land use: ……year

Comments:

Sheet # 2

***Botanical Name** & **Local Name** (if available)*	**Plant counts and percentage cover per quadrat**										
	Quadrat Number	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*
	Numbers										
	% Cover										
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	% Cover										
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APPENDIX II

FRAMEWORK FOR INTERVIEWS ON CHANGES IN BIODIVERSITY
Key for scores: 0= None or nearly none; 1=Some but not many; 2=Many

1. POLLEN PLANTS THAT ARE DISAPPEARING (FOR BEEKEEPERS)

NAME (local language & botanical)	USES	WHERE FOUND (land use)	YEARS	SCORE ON AVAILABILITY	REASON FOR THE SCORE
			1950-59		
			1960-69		
			1970-1979		
			1980-89		
			1990-99		
			2000-		
			1950-59		
			1960-69		
			1970-1979		
			1980-89		
			1990-99		
			2000-		
			1950-59		
			1960-69		
			1970-1979		
			1980-89		
			1990-99		
			2000-		

Note: replicate form to add additional species as needed

FRAMEWORK FOR INTERVIEWS ON CHANGES IN BIODIVERSITY
Key for scores: 0= None or nearly none; 1=Some but not many; 2=Many

2. MEDICINAL PLANTS THAT ARE DISAPPEARING

NAME (local language & botanical)	USES	WHERE FOUND (land use)	YEARS	SCORE ON AVAILABILITY	REASON FOR THE SCORE
			1950-59		
			1960-69		
			1970-1979		
			1980-89		
			1990-99		
			2000-		
			1950-59		
			1960-69		
			1970-1979		
			1980-89		
			1990-99		
			2000-		
			1950-59		
			1960-69		
			1970-1979		
			1980-89		
			1990-99		
			2000-		

Note: replicate form to add additional species as needed

FRAMEWORK FOR INTERVIEWS ON CHANGES IN BIODIVERSITY

Key for scores: 0= None or nearly none; 1=Some but not many; 2=Many

3. PLANTS FOR INCOME, CRAFT USE THAT ARE DISAPPEARING

NAME (local language & botanical)	USES	WHERE FOUND (land use)	YEARS	SCORE ON AVAILABILITY	REASON FOR THE SCORE
			1950-59		
			1960-69		
			1970-1979		
			1980-89		
			1990-99		
			2000-		
			1950-59		
			1960-69		
			1970-1979		
			1980-89		
			1990-99		
			2000-		
			1950-59		
			1960-69		
			1970-1979		
			1980-89		
			1990-99		
			2000-		

Note: replicate form to add additional species as needed

APPENDIX III.

SAMPLE HOUSEHOLD QUESTIONNAIRE
SURVEY ON CHANGING LAND USE AND SOIL PRODUCTIVITY
LUCID PROJECT

NOTE: All responses are confidential and will be used for statistical purposes only.
Respondents are free to not answer any question.

IDENTIFICATION	INTERVIEW
Name of husband________________________ Name of wife___________________________ Village_________________________________ Sub-Location, Location___________________	Name of interviewer____________________ Date________________________________ Time started___________________ Time finished__________________

1. *a. Questions about the husband if living:* **How old is the husband?** ___________years

   b **Level of education of husband:** 0-none 1-primary 2-secondary 3-post-secondary 4-adult ed

   c. **Clan of husband:**______________________________

   d. **What is his primary employment?** work:_______________________________

   e. **What is his secondary employment?** work:_____________________________

   e. **Does the husband live on the farm full-time?** *(explain if wife is widowed, separated, if family is polygamous)* 1. yes 2. no

   If not, **Where does he live?** ___________________________________

2. **Who is the acting head of the household?** 1. woman 2. man

3. a. **Where was the husband born?** ______________sub-location, _____________location

   b. *If moved, reason why:*____

4. a. **How old is the wife?** ___________________years

   b. **What is her primary employment?** work:______________________________

5. a. **How many sons over 20 years live ON the farm?** ________________sons

   c. **Do any of the sons living here WORK outside the farm?** _________sons

What work each does: ____

____

d. **How many sons over 20 years live OFF the farm?** _______sons *(if none, put 0, go to Q 6)*

note for each son, continue on back if necessary:

Where he lives:	**What work he does:**
1.a.________________________	1.b.________________________
2.a.________________________	2.b.________________________

6. **How many adults work on this farm?** (include wives, sons, daughters-in-law, etc.)

   full-time:______________ part-time:______________

7. **What crops bring the most money on this farm?** *include miraa, green grams, etc.*

   rank in order: 1.________________ 2.________________ 3.______________

8. **What crops bring the most food for your family on this farm?**

   rank in order: 1.________________ 2.________________ 3.______________

9. **In a normal year, do you produce enough food for your family?**
   1. yes 2. no

   comments: ____

10. a. **How did you acquire this plot of land?** *the farm, land with homestead*

    1. Bought 2.Rented 3.Inherited from parents 4.Inherited from clan 5.Given by govt 6. Other (explain)

    b. **What year did you acquire this land?** Year:_________

    c. **What was on the land when you acquired it?**
    1. Forest/Mititu 2.Grazing land/Igundu 3.Bush/Kithaka 4.Crops/Irio 5. Other___________________

    d. **How many acres is this plot of land?** ______________total acres

    e. **How many acres are being cropped?** _________cropped acres

    f. **Who has title deed to this land?** ___________________________

11. a. **Do you have OTHER plots of land?** 0-no (go to Q. 14) YES, ______other plots

    b. **How did you acquire the other plots of land?**
    1. Bought 2.Rented 3.Inherited from parents 4.Inherited from clan 5.Given by govt 6. Other (explain)

    c. **What year(s) did you acquire the other plots of land?** year_________

    d. **What is on the other land NOW?**
    1. Forest/Mititu 2.Grazing land/Igundu 3.Bush/Kithaka 4.Crops/Irio 5. Other____________________

e. **Where is this plot of land?** Location: ___________________

f. **How many acres is this plot of land?** _________acres

12. a. **Do you hire any people to work on your farm?**
1. yes 2. no (go to Q. 18)

b. *If yes*, **How many people do you hire?**

how many? ______ permanent _______temporary ______work parties (irima)

13. **Does anyone in the family ever work on other people's farms?**
1. yes, permanent 2. yes, temporary 3. no

14. **Do you own any animals?**

Type of animal	**Number own** (if none put 0) include young	**How fed** (zero grazed, tied up, grazed on own pasture, on fallow plots, on neighbour's land, on common pasture, fed cut grass, etc.). List two most important.
Native cattle		
Cross-bred cattle		
Donkeys		
Goats		
Sheep		
Pigs		

15. Table on techniques for improving soil fertility

Technique	**Do you use it?** 1=no (go to next) 2=yes	*If use* **What crops do you use it on?**	**Since you started cultivating, have you reduced or increased your use of this technique?** 0=NO change (go to next) Reduced: 1=a bit 2=allot Increased: 3=a bit 4=allot	*If changed* **Why have you reduced or increased your use of this technique?** *If increased:* Did you use it before? When did you start using it? Why use it now? *If decreased* Why did you use it before and not now?
a. Household residues		crops put on:		
b. Animal manure				
c. Stone bunds		on what crops, with what material		
d. Fanya juu			Increased or decreased the number of fanya juu?	
e. Erosion trench			Increased or decreased the number of trenches?	

Table on techniques for improving soil fertility, continued

Technique	**Do you use it?** 1=no (go to next) 2=yes	*If use* **What crops do you use it on?**	**Since you started cultivating, have you reduced or increased your use of this technique?** 0=NO change (go to next) Reduced: 1=a bit 2=allot Increased: 3=a bit 4=allot	*If changed* **Why have you reduced or increased your use of this technique?** *If increased:* Did you use it before? When did you start using it? Why use it now? *If decreased* Why did you use it before and not now?
f. Grass lines				
g. Trash lines				
g. **Chemical fertilizers**				
h. Fallow (resting soil)		How many seasons fallow? _________ How many seasons cropped? ___________	Do you fallow less or more often? Did you change the number of seasons?	

APPENDIX IV

SAMPLE FIELD QUESTIONNAIRE: LUCID PROJECT

Name of Husband:_____________________ **Name of Wife**________________________

Interviewer:_________________________☐ **of Field** : __________ **HH ID:** _________

1. **Circle the location of the field on the hillside:**
   1-hilltop 2-shoulder 3-mid hill 4-foothill 5-valley 6- flat (no hill)

2. **Distance from house in minutes walking**: ___________minutes.

3. **Estimate the slope of the field:**
   1-none to slight (0-4 degrees) 2-a bit (5-9) 3-medium (10-14) 4-steep (15+)

4. **Do you own or rent the field?** *If own,* **How did you acquire it?**

   If own:
   1 - Inherited from parents
   2 - Bought
   3 - Given by government
   4 - Given by clan

   If rent/borrow,:
   5 - Rented for money
   6 - Borrowed (for free)
   7 - Exchanged
   8 Other (explain)__________________________

5. **When did you acquire this field?** in 19_______

6. **What was on this field when you first acquired it?**
   1. Forest 2. Grazing land 3. Bush 4. Crops 5. Swamp 6. Woodlot 7.Other______________________

7. **How have you used it since you first acquired it?** (e.g. cleared, planted crops, grazed, abandoned...)

   ____

   ____

8. **What was on the field last season?** (include bush, grass, what crops, etc. *in order of importance*.)

   (Feb-June '01) :____

   ____

   How **many months is the land covered by crops during the year**? _____months

   How many months is the land covered by crop residues during the year? ____months

9. **What is the name in the local language of this soil?** (pls translate into English)

   Local language: ________________________________
   English:_____________________________

10. **How fertile is the soil of this field?**
    1. Very bad **2**. Medium **3**. Very fertile

11. a. **Since you started cultivating this field, has the soil fertility changed?**
0 - no, no change   Worsened: **1**-a bit **2**-allot   Improved.: **3**-a bit **4**-allot

b. **Why has the soil fertility worsened, improved or stayed the same?**

*because*____

____

____

12. a. **Have you fallowed (rested) the soil on this field?** **1**-yes **2**-no (go to Q. 16)

b. *If yes*, **When did you last fallow?** from 19_______ to 19______

13. **How do you prepare this field for planting?**
1-ox plough 2-tractor 3-hoe

14. b. **Is there erosion on this field?**
0-no, no erosion (go to Q. 18) **1**-yes, a little erosion **2**-yes, much erosion

c.**Does the erosion affect the soil fertility of this field?**
1-yes **2**-no

explain:____

15. a. **Is there a soil and water conservation structure on this field?**

1-yes, step terrace 2. yes, fanya juu 3-yes, stone bund 4-yes, trash line 5-no (go to Q. 21)

b. **WHEN did you construct it?** in 19______________

c. **How did you LEARN of the technique?**

____

16. Table of soil characteristics

Characteristic	**How is this in the soil?**	**Has there been a change in...?** 0=NO change (go to next) Decrease: 1-a bit 2-allot Increase: 3-a bit 4-allot	*IF CHANGE* **Why has there been an increase or decrease?** because...
Depth of top soil	a-deep b-shallow ____________inches		
Water holding capacity	a-good, holds water b-poor, dries out ___________days holds water		
Colour	NO ANSWER NECESSARY	Did the colour change? 0-no change Changed... From : To:	Why did the colour change?

17. **Do you use this ... on this field this season?** *Circle the appropriate code for each technique or input*

a Household residues **0**-no **1**-yes, a bit **2**-yes, allot
b. Animal manure **0**-no **1**-yes, a bit **2**-yes, allot

c. Grass strip **0**-no **1**-yes
d. Trash line **0**-no **1**-yes
e. Wood ash **0**-no **1**-yes

f. Chemical fertilizer **0**-no **1**-yes
g. Fungicide (eg copper, dethane M45) **0**-no **1**-yes
h. Insecticide (eg Ambush, smithion) **0**-no **1**-yes

i. Other? ___________________________________

APPENDIX V

VISUAL INDICATORS OF LAND DEGRADATION

The following table summarises the main visual indicators for the different types of land degradation. It must be remembered that these types of land degradation are inter-related. See PLEC guidelines on land degradation for explanations of terms. Although we are not likely to record or study all these forms of soil & land degradation indicators we include this PLEC list in the work book to serve as a field reference. Since we are working in many and diverse sites this reference is likely to include all forms degradation likely to have occurred in all our sites.

Visual Indicator	*Types of Soil & Land Degradation*					
	Water Erosion	*Wind Erosion*	*Salinity or Alkalinity*	*Chemical Degradation*	*Physical Degradation*	*Biological Degradation*
Rills	✓	✗	✗	✗	✗	✗
Gullies	✓	✗	✗	✗	✗	✗
Pedestals	✓	✓	✗	✗	✗	✗
Armour layer	✓	✓	✗	✗	✗	✗
Accumulations of soil around clumps of vegetation or upslope of trees, fences or other barriers	✓	✓	✗	✗	✗	✗
Deposits of soil on gentle slopes	✓	✗	✗	✗	✗	✗
Exposed roots or parent material	✓	✓	✗	✗	✗	✗
Muddy water/mudflows during and shortly after storms	✓	✗	✗	✗	✗	✗
Sedimentation in streams and reservoirs	✓	✗	✗	✗	✗	✗
Dust storms/clouds	✗	✓	✗	✗	✗	✗

sandy layer on soil surface	✗	✓	✗	✗	✗	✗
Parallel furrows in clay soil or ripples in sandy soil	✗	✓	✗	✗	✗	✗
Bare or barren spots	✓	✓	✓	✓	✗	✗
Efflorescence	✗	✗	✓	✗	✗	✗
Soil particles unstable in water	✗	✗	✓	✗	✗	✓
PH	✗	✗	✓	✗	✗	✗
Nutrient deficiency/toxicity symptoms evident on plants	✓	✗	✗	✓	✗	✓
Increased incidence of plant disease/morphological irregularities (e.g. stunting)	✗	✗	✓	✓	✓	✗
Decreasing yields	✓	✓	✓	✓	✓	✓
Changes in vegetation species	✓	✗	✓	✓	✗	✗
Plough pan	✗	✗	✗	✗	✓	✗
Restricted rooting depth	✓	✗	✗	✗	✓	✗
Structural degradation, including compaction	✗	✗	✓	✗	✓	✗
Poor response to fertilisers	✗	✗	✗	✓	✗	✓
Decrease in organic matter (lighter-coloured soils)	✓	✗	✓	✗	✗	✓
Increased sealing, crusting and run-off; reduced soil water	✗	✗	✓	✓	✓	✓
Decrease in number of earthworms/ants and similar	✗	✗	✗	✗	✗	✓

APPENDIX VI

SOIL FERTILITY AND EROSION INDICATORS

AEZ: **INDICATOR**	**High Moderate**	**Low**	NOTES
Farm Soil Fertility Assessment Indicator: **Soil Texture Estimation :** • Soil Texture **Plant Leaf - Soil Fertility Calibration:** • Soil colour • Yellowness of whole leaves and plant height • Growth and colour • Yellowness of leaf edges and plant height **Qualitative Ranking** • Soil organic matter • Availability of N • Availability of P • Availability of K • Soil organic matter • Availability of N • Availability of P • Availability of K **Assessment :** • Plant growth is vigorous • Plant growth is normal • Plant growth is stunted • Colour of plant leaves is dark green. • Colour of plant leaves is yellowish throughout affected leaves. • Colour of plant leaves is yellowish at the tips and along edges • Colour of plant leaves is purple on older leaves			

Aggregate Stability Demonstration • Aggregate stability • Organic matter (as most important component of aggregate stability) **Soil Water and Erosion Erosion Nails (Pins) Abts.** • Soil loss • Sedimentation • Accumulation **Class** EO: No visible evidence of erosion or very slight sheetwash. EL: Slight - moderate sheetwash. E2: Moderate - severe sheetwash. E3: Moderate - severe sheetwash. **Crop Yield Assessment Soil Fertility:** • Crop yield • Field Productivity **Visual Indicator** • Rills • Gullies • Pedestals • Armour layer • Accumulations of soil around clumps of vegetation or upslope of trees, fences or other barriers • Deposits of soil on gentle slopes • Exposed roots or parent material • Muddy water/mudflows during and shortly after storms • Sedimentation in streams and			

reservoirs • Dust storms/clouds • Sandy layer on soil surface • Parallel furrows in clay soil or ripples in sandy soil • Bare or barren spots • Nutrient deficiency/toxicity symptoms evident on plants • Decrease yields • Poor response to fertilizers • Increased sealing, crusting and run-off; reduced soil water			