THE REPUBLIC OF UGANDA

MINISTRY OF WATER AND ENVIRONMENT

MANUAL FOR IMPLEMENTING ECOSYSTEM BASED ADAPTATION IN MOUNT ELGON ECOSYSTEM OF UGANDA

MARCH 2015

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FOREWORD

This manual for implementing Ecosystem Based Adaptation (EBA) in the Mount Elgon Ecosystem of Uganda is a simplified tool aimed at to support extension services. This manual is intended for use by extension service providers and stakeholders who work at influencing policy at the various levels. The manual has been developed under the auspices of the partnership of United Nations Development Programme (UNDP), the International Union for the Conservation of Nature (IUCN), District Local Governments of Bulambuli, Sironko, Kween & Kapchorwa and other implementing partners with funding from the Federal Ministry of Environment Nature Conservation, Building and Nuclear Safety (BMUB) for the Mountain ecosystems of Uganda.

The manual is divided into six sessions and five principle learning areas. The main lessons from this manual are on: understanding climate change and its impacts; mapping of climate change impacts using practice sessions; planning for climate change adaptation; ecosystems, ecosystem services and ecosystem based adaptation; and implementing soil and water conservation – EBA in the Mt. Elgon ecosystem.

The manual was developed based on lessons learned from the Natural Resources Economic Analysis and drawing on issues raised in the Vulnerability Impact Assessment (VIA). Through piloting components of the manual as part of building the Business Case for EBA in the Mt. Elgon ecosystem, stakeholders were able to actively contribute to the development of this manual.

The Ministry of Water and Environment (MWE) is convinced that this manual will be an invaluable tool in the implementation of EBA in the Mt. Elgon ecosystem. Whereas new topics and wider issues are likely to emerge as EBA progresses, this instrument will serve as a good guide for Stakeholders, the District Local Governments ,the farmer groups and associations that we engage with from day to day.

Daivid O. O. Obong
Permanent Secretary
Ministry of Water and Environment

ACKNOWLEDGEMENTS

Gratitude to the Ministry of Water and Environment for the leadership it offers to the implementation of the Ecosystem Based Adaptation (EBA) project in Uganda. This manual represents another important tool and milestone in the process of ensuring that EBA is more widely adopted in adaptation planning and implementation in Uganda.

Similarly, special thanks are extended to the District Local Governments of Bulambuli, Kapchorwa, Kween and Sironko who participated in the activities that supported the development of this manual. Gratitude is also extended to the EBA Project Management Unit, under the leadership of Mr. Paul Nteza, the Ministry of Water & Environment staff in the Directorate of Environment Affairs (DEA) for reviewing the document and the entire Energy and Environment Programme for the technical oversight over this output. Finally, thanks to the Natural Resource Economist –Mr. Moses Masiga together with his team who were contracted to put this beautiful piece of work together.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

HOW TO USE THIS MANUAL

This manual has been developed to support extension services on EBA in Uganda. The manual is intended for use by extension service providers and by trainers of trainees (TOTs) who have participated in instruction and training on EBA. Whereas the manual is generally simplified in language there may be new terms, see Annex-glossary, which will require technical support for interpretation to farmers. Therefore, it is important that the users of this manual are knowledgeable on the subject of ecosystems, ecosystem services and a rough understanding of ecosystem based adaptation. The manual will be implemented in parts as some of the sessions would take the full length of the day, for a comprehensive single application of the manual, one week of training and practice sessions is recommended. However, what is envisaged is that the manual will be implemented in parts over a long period of perhaps a month or several weeks. The leaners can go away and practice and then move onto the next topic or session.

Section 1: is a very brief introductory session. The purpose of this session is to allow the trainer to assess the level of understanding of the trainees. The questions at the end of the session are answered by show of hands and illustrated on a flip chart or a black board. Where these materials are absent note books can be used.

Session 2: Understanding climate change and its impacts. The principal purpose of this session is to lead learners to a point where they appreciate the difference between a business as usual scenario or taking no action, climate change mitigation and climate change adaptation. Before they get to the decision making point learners are expected to progress in understanding of climate change, anthropogenic causes of climate change. The impacts of climate change using examples from their own ecosystem. Their likely contribution and what they can do to reduce or minimise impacts.

Session 3: Mapping climate change impacts using practice sessions is an elementary decision mapping process that is based on learners undertaking of the community and working with learners to specify ecosystems, ecosystem service flows, institutions and centres of power and partnerships. The session builds on livelihoods learning approaches. The result should be a simplified map that allows implementers of adaptation programmes to visualise the community understanding of climate change, ecosystems and ecosystem services and vulnerability to climate change

Session 4: Planning for climate change adaptation is a key entry point for climate change adaptation programmes and projects within communities. The community together with the trainers will work on separating issues that require a focus for adaptation and those that do not. The training will highlight vulnerabilities and move away from exposure and sensitivity to adaptive capacity. The focus on adaptive capacity will allow the communities to: identify resources; social, natural, economic, human; knowledge; innovations; institutional arrangements; strategic focus that will lead them to a greater ability for adaptation to climate change. The community will prioritise the actions they need to undertake and establish goals, objectives, inputs, develop a timeline for undertaking action. Together with support of trainer this information will be documented. Suffice to note that the climate change adaptation planning is not often a regular component of training sessions. It is often a hands-on activity that is undertaken with a purpose of planning for adaptation. However, its components on identifying actions, prioritising and planning inputs and timelines in a participatory manner have far reaching aims. The planning will allow the community achieve ownership of actions but also develop similar plans in future for similar activities. The capacity built will stay for future engagement.

Session 5: Ecosystems, ecosystem services and Ecosystem Based Adaptation. It may seem at this stage that the prior discuss has already covered a reasonable breadth of what this session is about.

But in fact this session is very much a knowledge and understanding session. The learners need to be moved from a simple understanding of basic understanding of goods and services from ecosystems into understanding the functioning of ecosystems. The basic premise of adaptation for communities is that the functioning of an ecosystem is factored into day to day decisions; for what crops to produce, what trees to harvest, where the water for production and other uses is extracted from. Understanding this session is extremely crucial to a successful adaptation programme.

Session 6: Implementing soil and water conservation – EBA in the Mt. Elgon ecosystem builds from session 5 and all other prior session to establish a programme that is a priority for the conservation of the Mt. Elgon ecosystem. Economic assessments and vulnerability assessments have indicated that soil conservation and water conservation are the main interventions for EBA in the Mt. Elgon ecosystem. This manual presents a case that can become standard practice for EBA using hill side ditches and accompanying agronomic and vegetative measures the communities within the ecosystem can consolidate current practice with the ideas proposed in this manual to transform the management of the ecosystem and assure the success of an EBA.

SESSION 1: INTRODUCTION

ABOUT THE MANUAL

This manual for ecosystem based adaptation (EBA) is based on the case study of the EBA project for the Mount Elgon Ecosystem covering the four Districts of Kapchorwa, Sironko, Kween and Bulambuli in Eastern Uganda. The manual has been specifically developed for use in undertaking ecosystem based climate change adaptation actions in Mountain ecosystems with particularly focus in Uganda but scalable to Mountain ecosystems of Eastern Africa.

The EBA project is a four year project funded by the Federal Ministry for Environment, Nature Conservation Building and Nuclear Safety of Germany (BMU), while the project itself is a joint and complementary effort of the United Nations Environment Programme (UNEP), the United Nations Development Programme (UNDP) and the International Union for Conservation of Nature (IUCN). UNEP provides overall coordination of the project while UNDP and IUCN are responsible for country level coordination through the UN country teams. The overall objective of the project is to strengthen the capacities of the participating countries, Peru, Nepal and Uganda, to strengthen ecosystem resilience for promoting ecosystem based adaptation options and to reduce the vulnerability of communities, with particular emphasis on mountain ecosystems. The project aims to create new opportunities for experimental learning between regions and among countries with the same region. Through parallel and cooperative development and application of methodologies and tools, and implementation of pilot projects, the project will shorten the learning curve of local and national institutions and fast track the transfer of knowledge and experience for building ecosystem resilience (UNEP 2011).

TARGETED AUDIENCE

Project managers and field staff

This manual is primarily intended for use by field staff engaged in designing and implementing ecosystem based climate change adaptation actions in Mountain ecosystems with particularly focus in Uganda but scalable to other Mountain ecosystems.

Local Government and NGOs

Local government and non-governmental organizations can use this manual to help inform and implement a more flexible and responsive approach to climate change adaptation planning.

Communities

One of the major ecosystem principles in EBA is to maintain ecosystem services by conserving ecosystem structure and functioning, recognizing that ecosystems have limits, undergo change and are interconnected. Communities need to understand how well EBA interventions are working, to strengthen climate change adaptive decision-making at the community-level with guidance from EBA partners.

INITIAL ASSESSMENT OF LEARNERS

	Score			
Assess participants understanding of climate change (indicate the number of trainees stating a given score)	0-25%	25-50%	50-75%	75-100%

This will help the facilitator know how to guide participants through the next session on climate change depending on the level of participants' knowledge about the issue.

SESSION 2: CLIMATE CHANGE & IMPACTS

Objective: By the end of this session participants will be able to:

- ✓ Understand the concept of climate change
- ✓ Understand the causes of climate change
- ✓ Identify climate change issues and impacts experienced in their area
- ✓ Identify current coping climate change strategies used in their area

Questions

i. What do you understand by the term climate change?

ii. What causes climate change?

iii. What climate change issues being experienced in this area?

iv. What climate change impacts experienced in this area?

v. What interventions or coping mechanisms for reducing the impacts of climate change listed above?

GUIDING TOOL 1:

Steps	Activity	Materials needed	Time
Step 1	A facilitator with a clear understanding of what is known about climate change guides the process.	A power point projection	45 minutes
Step 2	The facilitator guides participants through the causes of climate change as the first step	Flip chart	2 hours
Step 3	Provide information for baselines and s reflection and learning towards increasing adaptive capacity.	Markers	1 hours
Step 4	Feedback with trainees: Essential for participants to clearly understand the issue of climate change, causes, issues and impacts.	A blackboard & charcoal	45 hour

NOTES FOR THE SESSION

What is climate change?

Climate change is a long-term shift in weather conditions identified by changes in temperature, precipitation, winds, and other indicators. Climate change can involve both changes in average conditions and changes in variability, including, for example, extreme events.

What causes climate change?

The factors that cause climate change can be divided into two categories. The first category comprises natural processes, while the second category consists of processes related to human activity.

Natural causes of climate change

- The two most important natural causes of climate change are volcanic activity and a change in solar radiation (radiation from the sun).
- Volcanic eruptions are periodic or occasional and have relatively short-term effects on climate.
- Changes in solar radiation contributed to climate trends in the past century. However, the effect of the additions of greenhouse gases to the atmosphere since the industrialization of developed countries has been about ten times that of the effect due to changes in the Sun's output.

Human causes of climate change

- Climate change can also be caused by human activities that emit greenhouse gases into the atmosphere.
- The majority of greenhouse gases come from burning fossil fuels to produce energy. Although, deforestation, industrial processes, and some agricultural practices also emit gases into the atmosphere.
- Human influences on the climate system have increased substantially due to industrialization in the developed countries. Over the past century, human activities have released large amounts of carbon dioxide and other greenhouse gases into the atmosphere.
- The build-up of greenhouse gases in the atmosphere has enhanced the natural greenhouse effect. Greenhouse gases act like a blanket around the Earth, trapping energy in the atmosphere and causing it to warm. This phenomenon is called the greenhouse effect, and it is natural and necessary to support life on Earth. However, the build-up of greenhouse gases can change Earth's climate.
- It is this human-induced enhancement of the greenhouse effect that is of concern, because ongoing emissions of greenhouse gases have the potential to warm the planet to levels that have never been experienced in the history of human civilization. Such climate change can have far-reaching and unpredictable environmental, social, and economic consequences.

Greenhouse gasses

The greenhouse effect is a *natural process* that warms the Earth, and, in fact, is quite necessary for our survival. Gases in the atmosphere, like water vapour (clouds), carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) act as a natural blanket by preventing the sun's heat energy from radiating back into space, much like a greenhouse traps the Sun's energy to warm someone's plants even in the middle of winter. The natural greenhouse effect helps warm the Earth's surface by as much as 33°C, and without it, our planet would be too cold for humans to survive.

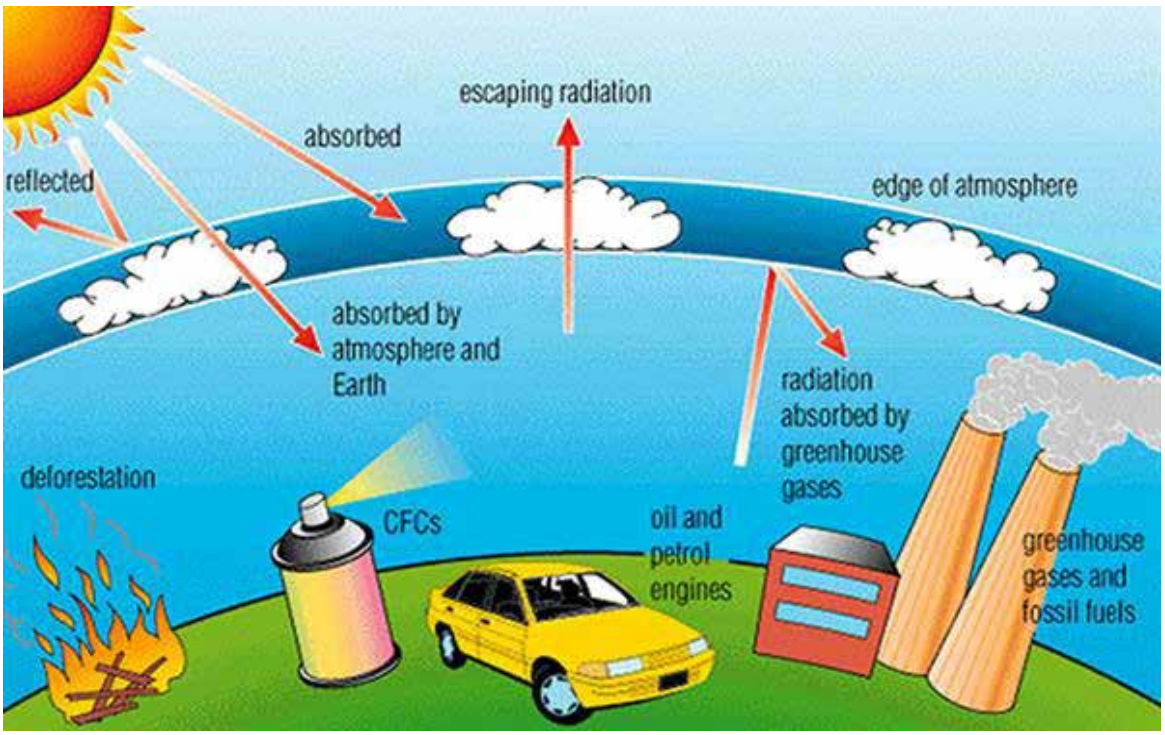


Figure 1: illustration of cycle of anthropogenic climate change
Source: Masiga et al. 2014

As the Sun's energy hits the Earth, some of that energy is absorbed by the Earth's crust and by the oceans, warming the planet. The rest of the energy is radiated back toward space as infrared energy. While some of this infrared energy does radiate back into space, some portion is absorbed and re-emitted by water vapour and other greenhouse gases in the atmosphere. This absorbed energy helps to warm the planet's surface and atmosphere just like a greenhouse.

Table 1: Greenhouse gases and their anthropogenic sources

Greenhouse gases	Anthropogenic sources
Carbon dioxide	Fossil fuel combustion, land use conversion, cement production
Methane	Fossil fuels, rice paddies, waste dumps, livestock
Nitrous oxide	Fertilizer, industrial processes, combustion
CFC-12	Liquid coolants, foams
HCFC-22	Liquid coolants
Perfluoromethane	Production of aluminum
Sulphur nexa-flouride	Dietectric fluid

Source: Masiga et al. 2014

Although the greenhouse effect is a naturally-occurring process, humans have recently amplified the natural effect by increasing the concentration of CO_2 and other greenhouse gases in the atmosphere (primarily through fossil fuel use in the energy and transportation sectors). According to the most recent report by the Intergovernmental Panel on Climate Change (IPCC's 4th Assessment Report), there is greater than a 90% chance that human activity is causing the increase in the Earth's global average temperatures observed since the mid-21st century.

Climate change issues and impacts

There are four major climate change issues identified by the vulnerability assessment. They include floods, landslides, drought and soil erosion

- Recent changes have been observed, which are widely perceived to be related to longer term climate change. The Mt Elgon ecosystem is particularly vulnerable to climate change impacts, including floods and landslides. In March 2010, following unusually heavy rains, landslides occurred in the Bududa district of the Mount Elgon region. Landslides buried three whole villages and caused many deaths. Hundreds of households were displaced, two primary schools were destroyed and the main health centre serving the area was severely damaged.

- Vulnerability to climate change in Uganda is high due to heavy reliance on climate-dependent resources such as rain fed agriculture, natural disasters and poverty. At the same time, adaptive and mitigation capacity is low due to shortages of economic resources and technology. Further, Uganda's vulnerability to climate change is likely to increase.

- The Mount Elgon ecosystem is vulnerable to flooding and landslides as evidenced by the 2010 floods and landslides. Frequent landslides are an emerging issue in highland areas and due to high population densities land shortages have restricted livelihoods. Inappropriate land use i.e. cultivation of steep slopes, lack of contour ploughing and terracing, aggravate climate change impacts. In 2011, the District of Bulambuli was also strongly affected by landslides, which destroyed homes and crops.

- Eastern Uganda experiences a bimodal rainfall pattern but the length of the two seasons alternate randomly (UNDP EBA, 2011). Because of this unpredictability in rainy season length, crop failure is common leading to frequent threats of food insecurity. Soils in this area easily lose moisture through evaporation creating conditions in which drought conditions quickly arise during dry spells. Frequent landslides, due to erratic and heavy rains and high population densities, characterize the Mount Elgon watershed. Landslides, on virtually a yearly basis, affect some 490,000 out of the 1,330,000 people living in the Elgon area. Inappropriate land use, including cultivation of sleep slopes and lack of contour ploughing and terracing aggravate climate change impacts. The Mount Elgon ecosystem is increasingly vulnerable to variable rainfall patterns (UNDP EBA, 2011). In 2007, major parts of the Mount Elgon watershed experienced their heaviest rainfall in 35 years (One World, 2008). An estimated 50,000 households were affected, many people faced food insecurity due to the loss of their first and second season harvests, and water and sanitation facilities were severely impacted (NEMA, 2008).

- On Mount Elgon, unless adaptation is implemented, increasingly frequent emergency operations such as that of 2010 will be required. Preventing disasters before they occur costs far less than responding to disasters afterwards. And in addition to the economic costs of landslides and flooding, the environmental costs are substantial and lives are lost – an enormous social impact.

Dealing with climate change challenges

Climate change management generally involves three basic responses. These are: mitigation, adaptation, or leaving things as they are (business as usual):

- **Mitigation** refers to actions aimed at reducing the emissions of greenhouse gases responsible for climate change, so that less change occurs.

- **Adaptation** is dealing with the consequences of warming and other aspects of climate change, such as changes in extreme weather events.

- **"Business as usual" refers to responding to the challenge of climate change by maintaining the same actions as before**. This option saves expenditures for mitigation in the near term, but risks higher adaptation costs to wildlife, human populations, infrastructure, and economies later on. It also increases the odds of unforeseen consequences from unchecked climate change.

Ecosystems have limits beyond which they cannot function effectively; these limits are complex and not always predictable. In many cases it is not yet known exactly how climate change will affect specific ecosystems and, if and when, it will tip them beyond these limits. That said, ecosystem resilience to climate change is generally higher, if the system is in good condition and non-climate stressors such as habitat destruction, overharvesting of resources, and pollution are minimised. Hence promoting healthy and flexible ecosystems and reducing non-climate stressors are important approaches in maintaining ecosystem services for human adaptation and helping their component parts to adapt. For example, reforestation and conserving intact forests, maintaining or restoring connectivity between natural spaces, avoiding over-use of resources and reducing risk of forest fires can help increase resilience to climate change. This, in turn, helps to ensure continued availability and access to natural resources that support people's livelihoods, and to reduce their vulnerability to shocks, and ultimately to adapt to changing conditions. It can also reduce the risk of natural disasters such as landslides that may be triggered by more intense rainstorms.

It can take time for climate impacts on ecosystems to manifest themselves. EBA also takes temporal aspects into account, supporting adaptation to both current and future climate conditions, and promotes "no-regrets" strategies that make sense and provide tangible benefits with or without the impact of climate change.

In Uganda, climate change models point to an increase in temperature between 0.7°C to 1.5oC by 2020, and a likely increase in the variability of rainfall with most areas getting higher rainfall. Uganda has also experienced increased floods and storms, as well as more frequent droughts, which is influencing food security and increasing the threat of famine.

Assessment of participants

Questions	Score			
	0-25%	25-50%	50-75%	75-100%
1. Rate your understanding of climate change				
2. Rate your understanding of causes of climate change				
3. Rate your understanding of climate change issues and impacts				

The responses will help to guide the facilitator in determining the next course of action. Whether to go to the next session or spend more time clarifying to participants on some issues they did not understand well.

SESSION 3: PRACTICE - MAPPING CLIMATE CHANGE IMPACTS

Objective: By the end of this session participants will be able to:

i) Identify areas within the landscape that are vulnerable to the impacts of climate change

ii) Practically use the lessons of session 2 to identify ecosystems and map them within a landscape map as an activity done by the community.

iii) Specify the type of climate change impacts and describe the impacts for your own farmlands or that of your neighbours

Questions

i) Where are the impacts of climate change occurring?

ii) Where are ecosystems within the landscape and on the farms?

iii) Can you specify the climate change impacts occurring on the land?

GUIDING TOOL 3: GROUP WORK

Steps	Activity	Materials needed	Time
Step 1	Divide participants depending on their location e.g. by Village, Parish, Sub-Parish etc.	Power point projection	
Step 2	Participants draw their map (village, Parish, sub-Parish)	Flip chart	
Step 3	Name the important features like rivers, streams, forests, wetlands, villages	Markers	
Step 4	Indicate climate change impacts identified on the map (e.g. landslides, where do they occur?)	A blackboard & charcoal	

SESSION NOTES: PARTICIPATORY MAPPING

What Is Participatory Mapping?

Participatory mapping is a map-making process that attempts to make visible the association between land and local communities by using the commonly understood and recognised language of cartography. In contrast to the common view of planners and managers responsible for a certain development process, participatory mapping provides the opportunity to represent a socially and culturally distinct understanding of landscape and include information that is excluded from mainstream maps. Therefore, it can become a medium of empowerment by allowing the local community to represent themselves spatially (Lienert 2009).

Who Does Participatory Mapping?

Community maps should be drawn by various members of the community in order to capture different perspectives and issues. Women, men, and children may identify different land use and resource issues. Also, people from different social status and *background* may have differing perspectives, ideas, and issues (acdi-cida.gc.ca). The more people participate in a mapping process, the more insights on the issue can be collected. However, one should keep in mind that an issue becomes more complex and the process of mapping becomes more time consuming, the more people are getting involved.

Steps for Participatory Mapping

1. Ask the individual or the group to draw the boundaries of the geographic unit being discussed. Participants or the planner can decide how they want to represent this – on paper with writing or using local materials such as wet sand and earth with sticks, stones or seeds. Remember that whatever material is chosen, you will always need a paper-based copy to enable comparative analysis. If it adds to the discussion, three-dimensional elements can be added, transforming the map into a model that emphasises landscape-level aspects of issues. This base map can be multiplied and used for different contexts.

2. On whatever medium is chosen, ask the participants to draw the outline of the local area, for example, roads, towns, rivers and property boundaries. One way to do this, if you have the proper resources, is to project an overhead map onto a large sheet of paper and then to trace the required information.

3. Having prepared the map, which could be as large as a wall, people can then add their information either directly or by using sticky notes. Let them record what is most significant to them, and then ask for more detail if something you are interested in is missing. Motivate all the people present to add their perspective, without influencing them too much.

4. Several modifications to the map may be needed before those involved are happy with the final result. Include additional written comments such as quantities of interest, if necessary.

5. This map, representing the current state of affairs may be used later to make comparisons.

When Is Participatory Mapping Used?

Because every situation is different, it is not always clear when participatory mapping should be considered. Participatory mapping generally is not appropriate for minor decisions because the process can be time-consuming and requires significant planning.

Advantages

- It is relatively easy to conduct and easy to explain
- It allows to integrate local people at a very early stage, allows to tap local knowledge, and gives local people the feeling that their inputs are valued
- It produces a quick overview of problems
- It may foster holistic thinking among participants and may make the relations between different problems more easily understandable to them

Disadvantages

- Can be time consuming and cost intensive
- Can create dissonance and lead to conflicts under the involved stakeholders
- The larger the number of topics to be included, the more complex the maps will be. For this reason, it might be better to make several maps, with one issue/indicator per map. However, this is very time-consuming and storing such maps can pose difficulties.

SESSION 4: PLANNING FOR CLIMATE CHANGE ADAPTATION

Objective: At the end of this session participants will be able to

- ✓ Understand Climate change adaptation
- ✓ Know why climate change adaptation is necessary
- ✓ Draft local adaptation plans
- ✓ Understand the roles in planning and implementation
- ✓ Understand where the resources for implementing the adaptation plan

Questions

Can you differentiate climate change adaptation from other interventions?

Why is climate change adaptation necessary?

What are local adaptation plans?

How is a local climate change adaptation plan developed?

What is my role in developing the plan and implementing it?

GUIDING TOOL 4

Steps	Activity	Materials needed	Time
Step 1	A facilitator with a clear understanding of developing local adaptation plan guides the process	Power Point Project	45 minutes
Step 2	Understanding adaptive capacity & its use in adaptation planning	Flip Chart	1.5 hours
Step 2	Participants identify interventions for dealing with climate change impacts for each climate change issue	Calculators	3 hours
Step 3	Participants prioritise interventions	Black board & chalk	1.5 hours
Step 4	The process of developing a local adaptation plan starts	Writing books & pens	2 hours
Step 5	Finalise draft plan		45 minutes

SESSION NOTES

There is likely to be a range of adaptive measures a community could take. A single measure alone probably won't achieve large-scale goals such as would relate to climate change adaptation. More likely, communities and their members will need to combine complementary measures.

Adaptive measures

Adaptive measures can be organized into two categories:

1. Those that build adaptive capacity. They create information (through research, monitoring and awareness-raising), support organizations including governments and partnerships, and back up adaptive actions.

2. Those that deliver adaptation actions. This could include improving management structures (such as creating buffer zones where building is not allowed), building or modifying infrastructure and other structures, or applying new technology that physically improves the community's climate resilience.

Each community has to find approaches that work for its situation. Creative thinking is needed. Guidance may be available from state and federal agencies, but ultimately the members of the community will have to make the hard decisions.

Adaptation measures should be considered in light of these criteria:

- Do they provide direct benefits such as protecting property, preserving health or lowering costs?
- How effective are they at solving the problems they are intended to address?
- How much do they cost, and who will pay? Do they show a positive benefit cost ratio?
- Is implementation practical? Are they technically feasible in your location? Are they socially and culturally acceptable? Are they equitable; do they help at least some individuals without harming others?

No regrets measures produce benefits that are independent of any climate change related effects. The benefits exceed costs whether there is climate change or not. They make the community safer and more liveable and clearly would increase the community's resiliency in the face of the predicted effects. They provide benefits now and in the future. An example would be reducing leakage from a community water supply facility.

Low regrets options can produce big benefits for relatively low cost and produce a high return on investment or benefit-cost ratio. An example would be several communities getting together to build a larger water storage facility.

Win win measures enhance adaptive capacity or have other social or economic benefits. They address climate impacts while helping to solving other community problems. An example would be creating a community reservoir that would enhance water supply capacity in case of future drought while providing immediate opportunities for recreational fishing, boating and skating.

Flexible or adaptive management options can be applied incrementally, one step at a time rather than all at once. Adaptive management means not committing all resources to a fixed project but instead designing the response so that different approaches can be taken as new information or resources become available. Choosing to delay or take incremental steps can buy time to get more complete information and can reduce the risk of taking inappropriate or ineffective measures.

A final option is to do nothing, which may be appropriate for low-priority impacts or where other factors clearly outweigh climate-related risks. However, doing nothing shouldn't be the default response whenever there isn't enough information.

Why a focus on adaptive capacity?

One of the biggest challenges within development programming is how to ensure that individuals and societies can adapt beyond the programme cycle of an intervention (Levine et al. 2011). This is key to climate change adaptation because there is no end-point to which people have to adapt; people need to acquire the capacity to adapt for generations to come. The challenge to development practice is how to meet immediate needs whilst also building this capacity to adapt in the future. A focus on resilience alone does not necessarily bring in this perspective; a specific focus on adaptive capacity is needed. Adaptive capacity refers to the potential to adapt, as and when needed, and not necessarily the act of adapting or its outcome. Adaptive capacity is multi-dimensional and the elements that make up an individual's adaptive capacity are not entirely agreed. It essentially relates to whether people have the right tools and the necessary enabling environment to allow them to adapt successfully over the long term. It is also important to bear in mind that adaptive capacity is context-specific and varies from country to country, community to community, between social groups and individuals, and over time (Levine et al. 2011).

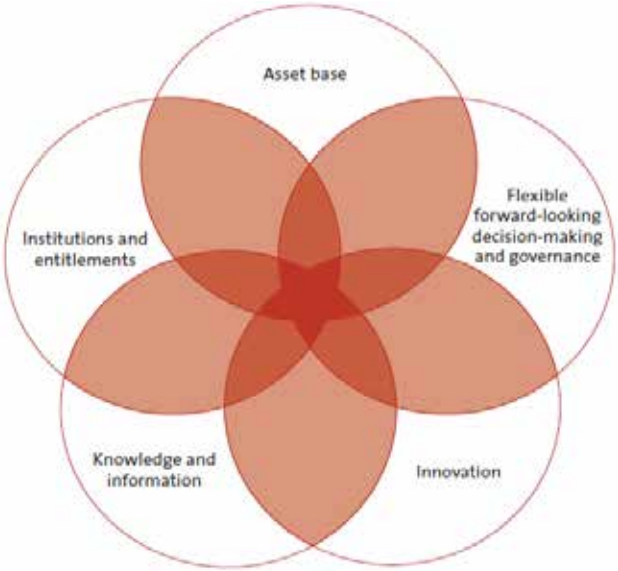


Figure 2: ACCRA Framework for thinking about Local Adaptive Capacity

Table 2: Adaptive Capacity at the local level

Characteristics	Features that reflect a high adaptive capacity
Asset base	Availability of key assets that allow the system to respond to evolving circumstances
Institutions and entitlements	Existence of an appropriate and evolving institutional environment that allows fair access and entitlement to key assets and capitals
Knowledge and information	The system has the ability to collect, analyse and disseminate knowledge and information in support of adaptation activities
Innovation	The system creates an enabling environment to foster innovation, experimentation and the ability to explore niche solutions in order to take advantage of new opportunities
Flexible forward-looking decision making and governance	The system is able to anticipate, incorporate and respond to changes with regard to its governance structures and future planning

Table 3: Adaptation and adaptive capacity

Type of Adaptation	Description
Autonomous Adaptation	Adaptation that occurs naturally by private actors without intervention of public agencies. Often, autonomous adaptation does not constitute a conscious response to climatic stimuli, but is triggered by ecological changes in natural systems and by market or welfare changes in human systems.
Planned Adaptation	Adaptation actions that are the result of deliberate policy decision or action on the part of public agencies.
Incremental Adaptation	Adaptation that results in small incremental changes, generally aimed at enabling a person or community to maintain its functional objectives under changing conditions.
Transformational Adaptation	Adaptation that results in a change in the individual or community's primary structure and function
Maladaptation	An adaptive response made without consideration for interdependent systems which may, inadvertently, increase risks to other systems that are sensitive to climate change.

Source: Levine et al. 2011

Adaptation within human systems can be broadly described as the *process* of adjustments to actual or expected climate and its effects, in order to moderate harm or exploit potential benefits (IPCC, 2007). Adaptation does not occur instantaneously; a person or community requires agency, ability and willingness to realise their adaptive capacity and adapt successfully (Adger et al., 2004). A suitable enabling environment is needed to ensure that individuals and societies are capable of making the changes necessary to respond to climate change and other changes.

Adaptation practices can be either anticipatory or reactive and, depending on the degree of spontaneity, can be autonomous or planned (Smith et al. 2010) – see Figure 1. Accordingly, there are distinctions between adaptation as a programmatic approach and adaptive actions and processes by households, communities or institutions themselves: the former is largely planned, seeking to facilitate sustainable and effective positive adaptation by the community as a whole and avoid maladaptation; the latter is generally associated with any such actions in anticipation of (or more commonly as a reaction to) shocks and stresses.

Indeed, it should be noted that adaptive actions are not necessarily positive, and short-term gains or benefits taken to adapt to changing shocks and stresses can in some cases lead to increased vulnerability in the long term – known as maladaptation (ADB, 2009). One important role of development partners is therefore to help households and communities to assess and understand current strategies to see which ones might lead to sustainable adaptation, and which ones to maladaptation.

Developing the adaptation plan

After the identification of the most significant risks posed by climate change, the real adaptation planning phase can start. Planning can be defined as the process of setting goals, objectives and targets and developing the appropriate strategies to accomplish them. In short, planning will help to define what the community want to achieve and how it will manage it.

At this stage it will be determined how best to address those risks, by identifying a range of adaptation options and then selecting preferred adaptation options using specific criteria. Adaptation options will be addressed to bring negative impacts at an acceptable level as well as take advantage of any positive opportunities that may arise from climate change.

Different activities are therefore needed at this stage:

- identifying the adaptation goals, objectives and targets to be achieved;
- formulating the strategies to achieve these goals, objectives and targets;
- defining cross-sectoral issues and identifying synergies and conflicts.

Options for adapting to climate change will vary from actions that build adaptive capacity (e.g. building knowledge base, sharing information, etc.) to concrete adaptation measures (e.g. green infrastructure, technical solutions, etc.)

A. Set the adaptation goals, objectives and targets

Setting adaptation goals and objectives will help provide a structure for the next steps, by identifying clearly what the community want to achieve through adaptation actions.

Useful questions

✓ In which way can I face the priority risks previously identified?

✓ Which targets do I have to achieve in order to manage the risks identified?

Based on priority risks (and eventually opportunities) identified in the previous steps, adaptation goals, objectives and targets will vary from one community to another one as a consequence of various factors, such as types and magnitude of projected climatic changes and impacts, availability of financial resources, areas on which the community has direct responsibilities and influence. This means that it is not possible to prescribe them in general, but they will have to be selected case by case, community by community.

However, it is important to take into account some common elements that should characterize goals and objectives. In fact, they should be as much as possible:

- **specific**: focus on important factors and avoid broad expression like "being more environmentally friendly";
- **achievable**: if the goals/objectives are too high it will be more difficult to accomplish them, and this will demotivate people working on them. It is also important to avoid setting too many goals;
- **realistic**: if goals/objectives are set too low, it may not be possible to reach the full potential for action;
- **prioritised**: prioritising will ensure that the most appropriate adaptation responses are selected.

Setting adaptation goals and objectives will help provide a structure for the next steps, by identifying clearly what the community want to achieve through adaptation actions.

The development of **adaptation goals** may be guided by the following considerations:

1. At this stage it is important that the Adaptation Team and the government leadership should agree on the goals. For this purpose, clearly written, attainable and measurable adaptation goals should be developed and shared by all their representatives.
2. Adaptation goals will require the identification of a time period for the accomplishment (e.g. 10, 20 or 50 years) that is consistent with other long-range planning programs.

3. Take into account that adaptation to climate change is an on-going process: policies and practices will be regularly re-evaluated in light of known and projected climate change impacts and other changes in the community.

Adaptation goals may be, for example:

- increasing public awareness on increased temperatures and their projected impacts on our community;
- increasing technical capacity to prepare for the impacts of increased precipitation

After the identification of the adaptation goals, it will be possible to set specific adaptation objectives, thus indicating the way in which the community intends to face the risks previously identified. In order to draft the objectives, it may be useful to rephrase each impact description and point out the potential improvement by reducing the severity of the impact.

Examples of adaptation objectives may be:

- to improve and diversify water supply;
- to slow down erosion, desertification and soil loss;

A number of adaptation targets will be defined just after the definition of goals and objectives. The aim of this step will be to break down the objective into tangible segments of effort. Targets should be linked therefore to specific objectives. Defining the timeframe of targets (now: by 2015; soon: 2015-2030; later: 2030-2050) will depend on the long-term and forward looking policy, as for example:

- to designate reliable shelters for warm extreme weather events by 2012;
- all the Departments of the Government will have screened the effects of climate change in their policies by 2012.

Adaptation targets may also include relevant numerical standard to measure the progress, such as:

- to improve energy conservation by 25%;
- to increase local food production by 20%.

It is important to define quantitative targets in order to measure and compare them with a reference or base year. In general, climate adaptation processes require both strategic and long-term (10-15 years) as well as operational and short-term targets (1-3 years) (ICLEI, Workbook for Municipal Climate Adaptation and GRABS Project). Adaptation goals, objectives and targets should be compared with other existing plans, strategies and regulations in terms of potential conflicts and synergies and in particular with existing National and Regional Adaptation Strategies or Plans.

B. Build a portfolio of adaptation options

Adaptation actions may be defined as actions aiming at managing the climate risks posed to human and natural systems as well as taking advantage of any positive opportunities that may arise.

Once defined adaptation goals, objectives and targets for the adaptation plan, it is time to build a portfolio of adaptation options that could help achieve them.

Adaptation actions may be defined as actions aiming at managing the climate risks posed to human and natural systems as well as taking advantage of any positive opportunities that may arise. This means that adaptation actions may be addressed to reduce sensitivity and/or exposure to climate change, or to enhance adaptive capacity.

These actions may include different behavioural, structural and technological adjustments, and can be grouped into different ways based on:

- timing: anticipatory versus reactive; ex ante versus ex post;
- scope: short-term versus long-term; localized versus regional;
- purposefulness: autonomous versus planned; passive versus active;
- adapting agent: private versus public; societies versus natural systems.

Building Adaptive Capacity (BAC) options involve developing the institutional capacity to respond effectively to climate change. These options include: i) creating the information (e.g. research, data collection and monitoring, awareness raising); ii) supportive social structures (e.g. organisational development, working in partnership, institutions), and iii) supportive governance (regulations, legislations, and guidance) that are needed as a foundation for delivering adaptation actions. These measures are fundamental to delivering responsive adaptation actions.

Delivering Adaptation Actions (DAA) include practical actions to either reduce vulnerability to climate risks, or to exploit positive opportunities and may range from simple low-tech solutions to large scale technological interventions. These options include: i) accepting the impacts, and bearing the losses that result from those risks (e.g. manage retreat from sea level rise); ii) Offset losses by sharing or spreading the risks or losses (e.g. through insurance); iii) avoiding or reducing one's exposure to climate risks (e.g. build new flood defences, or change location or activity); iv) Exploit new and positive opportunities (e.g. engage in a new activity, or change practices to take advantage of changing climatic conditions).

Green infrastructure: contribute to the increase of ecosystems resilience and can halt biodiversity loss, degradation of ecosystem and restore water cycles. At the same time, green infrastructure use the functions and services provided by the ecosystems to achieve a more cost effective and sometimes more feasible adaptation solution than grey infrastructure.

Adaptation options could be identified in other ways. The experience of other communities and other organizations facing similar problems in similar geographical contexts could be taken into account, by evaluating whether these are transferrable in time and space to the considered situation. Surfing on web portals such as, for example, Climate-Adapt, national web portals, and consulting database, research projects, and other relevant source could be a very helpful activity at this stage. A recent publication contributed to provide a great overview of practical and early examples of actual adaptive actions already taking place across Europe.

The actions illustrated aim to make a region or a city less vulnerable to the effects of climate change, enhance resilience or provide new opportunities and could inspire science, policy and practice in the adaptation field. Once a wide range of adaptation options has been identified, the Adaptation Team will collect all the hypothesis, analyse them, eliminate inappropriate proposals (e.g. those options that are not really adaptation options) and redundancies, checking potential overlapping with already existing relevant measures that are not labelled as adaptation, before proceeding to evaluate them.

C. Collect and organize relevant information on adaptation options

Once a wide "wish list" has been prepared, the adaptation options should be formulated and described in such a manner that their assessment, selection and prioritisation is feasible and will produce a short list of prioritized options for the further implementation.

Once a wide "wish list" is prepared, the adaptation options should be formulated and described in such a manner that their assessment, selection and prioritisation is feasible and will produce a short list of prioritized options for the further implementation. As part of the process, adaptation options should be first assessed and compared. For this reason, all the candidate adaptation options should be characterized and described with relevant information.

Table 4: Organisation of information required for local adaptation plan

Information	Description
Name of the action and description	Description of the contents and objectives of the adaptation action, how the action should be implemented
Social, economic & environmental context	Characteristics of the context in which the option may be implemented
Lead department	Potential role and responsibility of the lead department
Other relevant departments	Potential role and responsibility of any other departments that should be involved with planning and/or implementation
Financial resources	Description of the financial resources required for the implementation
Pre-cursors to action	What steps need to be taken to enable the implementation of an action (e.g. research studies, establishing partnerships, etc.)?
Timeline	Start and end dates; short, medium or long-term timelines; immediate or on-going actions, etc.;
Framework	Legal, institutional, policy framework
Expected results	Description of the results that are expected following the implementation of the action
Potential barriers	What are the potential barriers to the implementation of the action and the mechanisms to overcome these
Other information	

In some cases, some information will not be easy to access or elaborate at this stage as, for example, those on the availability of financial resources and the timeline. However, it will be important to try to collect as much information as possible in order to perform a better comparison of options.

D. Define criteria, assess, select and prioritize the adaptation options

Specific sets of criteria will guide the assessment of different adaptation options for the community.

Useful questions

- ✓ Which actions will allow meet the adaptation goals, objectives and targets?
- ✓ Is the action robust under a range of climate change scenarios?
- ✓ Can the actions be implemented, and in what time frame?

There is no "one size fits all" prescription for determining which adaptation actions are better than others. It is therefore very important that the Adaptation Team define a specific **set of criteria** that will guide the assessment of different adaptation options for the community. Thus, it will be helpful that each component of the Team will have a shared understanding of these criteria. Some criteria may be considered more important than others, and should be taken into particular account. As a general rule, it is important to remember that *proactive adaptation is generally more effective and less costly than reactive adaptation*.

Table 5: Criteria for prioritising adaptation options

Criteria	Description
Effectiveness	• It is able to meet the objectives and the guiding principles of the adaptation process (e.g. reducing impacts, reducing exposure, enhancing resilience or enhancing adaptive capacity) without impeding adaptation elsewhere or in the future • It is appropriate with respect to the severity of climate change impacts the options would address relative to other impacts expected in the community • It is cost-effective
Efficiency	• The (economic and non-economic) benefits gained from the action exceed the (economic and non-economic) costs of the implementation • It considers benefits in terms of economic, social and environmental costs
Equity	• It distributes the benefits of adaptation equally across society • It considers the effects on vulnerable groups, including economic, social, cultural and knowledge distribution considerations • It helps allocate risks in a fair manner in social terms • It is able to bring advantages for broad parts of society • It tackles threats for old, chronically sick and poor people
Flexibility	• It allows easily adjustments and incremental implementation later if (climate and non-climate) conditions change again or if (climate and non-climate) changes are different from those expected today • It can be adapted, revised or made undone at low cost
Sustainability, Impacts & Side-Effects	• It is sustainable and contributes to sustainability • It avoids the so-called maladaptation (e.g. to avoid introducing perverse effects, to avoid limiting future adaptation) • It brings benefits in terms of alleviating pre-existing problems (No-regret) • It entails side-benefits for other social, environmental or economic objectives (e.g. to help reduce social inequality, to decrease energy demand, to help raising resilience of ecosystems services, etc.) • It avoids affecting other sectors or agents in terms of their adaptive capacity • It avoids causing or exacerbating other environmental pressures • It has the potential role in protecting unique environmental or cultural resources • It should not limit the adaptive capacity of other communities, vulnerable populations, or future generations

Criteria	Description
Acceptability	• It is culturally, socially, environmentally and politically acceptable • It is accepted by those affected and by stakeholders
Urgency (Time Scale, Time-Lag, Lifetime)	• It is needed in case of high danger of significant impacts in the near future • It is appropriate in terms of timescale actions need to be taken with respect to the expected climate change impacts (e.g. short, medium and long-term climate change impacts) • There is a unique "window of opportunity" for implementing a particular action • It likely become costly (e.g. large and long-lived infrastructure projects), difficult to implement (e.g. spatial planning for nature conservation) or redundant (e.g. raising awareness) when postponed, and it therefore should be undertaken immediately (due to long time spans before they take effect). • The consequences of not acting are higher compared to the degree of risk in acting
(External and Internal) Coherence	• Is it aligned to the EU Adaptation Strategy and other sectoral policies? • It is coherent and support other development goals and priorities (including mitigation), and not just a "bolt-on". • Is the measure aligned with other local sector policies? • It is coherent with policy, investment, maintenance and other planning cycles • It includes potential conflicts and synergies within and across sectors
Robustness	• It reduces vulnerability under current climate, low-regrets, incorporate safety margins, mindful of actions by others • It is robust under different climate scenarios and different socio-economic scenarios • It is robust to changes in the frequency or severity of specific climate impacts • It reflects the range of uncertainty if the climate change is not the expected one (e.g. no regret measures)
Dependencies	• It complies with actions, legislation, regulatory framework, incentives, investments, externalities, etc. that are needed as pre-requisite to implementation
Deliverability & Feasibility	• It is easily and quickly feasible in legal, technical, social, institutional, political and financial terms and the barriers, when existing, can be overcome

Among all the potential adaptation options, no-regrets, low-regrets and win-win may be the most appropriate ones and should be used where possible. In fact, these options may be practical, cost-effective options delivering adaptation and able to minimise the risks even with existing uncertainties (UKCIP, 2005):

- **No-regrets options** - adaptive measures whose socio-economic benefits exceed their costs whatever is the extent of future climate change. This type of measures includes those that are cost-effective and justified under current climate conditions, and are further justified when their introduction is consistent with addressing risks associated with projected climate changes. Focusing on no-regrets options is particularly appropriate for the near term as they can deliver obvious and immediate benefits and can provide experience on which to build further assessments of climate risks and adaptation measures.

- **Low-regrets (or limited regrets) options**. Adaptive measures for which the associated costs are relatively low and for which the benefits, although primarily realised under projected future climate change, may be relatively large.

- **Win-win options**. Adaptation measures that have the desired result in terms of minimising the climate risks or exploiting potential opportunities but also have other social, environmental or economic benefits. Within the climate change context, win-win options are often associated with those measures or activities that address climate impacts but which also contribute to mitigation or other social and environmental objectives. These types of measures include those that are introduced primarily for reasons other than addressing climate risks, but also deliver the desired adaptation benefits (UKCIP, 2005).

These measures are useful in particular when the risks associated with inaction are high, and when the uncertainty and the risk associated with introducing inappropriate adaptation measures is also high. In this case, **flexible or adaptive management approach** could be useful. This approach in fact involves putting into practice incremental adaptation options rather than undertaking large-scale adaptation all at once. For the implementation of this approach, measures should be adopted in a sequential manner, based on an iterative evaluation of risks, costs, feasibility, etc. as knowledge, experience and technology evolve. At this stage, the Adaptation Team should have established the criteria for the selection and prioritization of the future adaptation actions. An active involvement of the relevant stakeholders should be promoted at this stage. It is important to take into account that these actions will not – and do not need to – meet all the selected criteria but a general rule will be that the more criteria are met, the more likely the action will help reduce the vulnerability to climate change (Snover et al. 2007). Selection and prioritisation of adaptation actions will represent then the further step which will allow to choose, reject or postpone actions for implementation (Table 6).

Table 6: Tools for prioritising local adaptation options

Tools	Description
Expert judgement	Assessment by experts in the field of probabilities and risks
Focus groups	Groups of stakeholders that discuss their opinions on specific topics
Brainstorming	Free-flowing lists/diagrams of all ideas and options
Cost-benefit analysis	Assessment of economic efficiency, assigning a monetary value to measure of effect
Cost-effectiveness	Economic analysis that compares the relative costs and outcomes (effects) of two or more courses of action
Delphi	Iterative, group-oriented, idea-generating strategy
Multi-criteria analysis	Examination of more than one and some non-monetary criteria involving subjective judgement
Decision/probability trees	Charts of relationships between decision modes
Influence diagrams/mapping tools	Graphic identification of options

Some useful consideration for the prioritization of actions could be the following:

- priority 1: actions that can be implemented in the current adaptation process;
- priority 2: actions that require additional information, knowledge and resources before being implemented. However, communities may want to explore them as part of the current planning activity;
- priority 3: actions that are not suitable candidates at this time, but could be in the future.

The actions identified in the previous steps will constitute the bulk of the Local Adaptation Plan. Of course, the need will be to move from a simple list of priority actions to a more formalized action plan. The information collected, together with the list of adaptation actions, should be structured so as to develop a detailed plan which sets out what needs to be done by whom, by when and how in order to convert the adaptation strategy into practical actions.

A. Draft the local adaptation plan and get the political approval

All the time and resources addressed to investigate climate change and its impacts assess vulnerabilities and risks posed by climate change, involve local stakeholders for the identification of adaptation options will be put together in a formal Local Adaptation Plan (LAP).

It is at this stage where all the time and resources addressed to investigate climate change and its impacts, assess vulnerabilities and risks posed by climate change, involve local stakeholders for the identification of adaptation options, will be put together in a formal Local Adaptation Plan.

Even though the decision on how to structure the Local Adaptation Plan is up to the Adaptation Team, it may be helpful to consider what are the main elements that could be included in the final version of the Plan.

Table 7: Table of contents of a Local Adaptation Plan

Element	Description
1. Acknowledgements	Acknowledgements are addressed to those people who have provided a contribution to the adaptation process within the community, e.g. the members of the Adaptation Team, the stakeholders, the members of the city Council, etc.;
2. Foreword or Commitment	Foreword or commitment is very important and helps demonstrate the official political engagement of the local administration to the adaptation process.
3. Executive summary	It provides the synthesis of the adaptation process developed and implemented at local level.
4. Glossary	It lists and explains the key terms which could be useful for the readers.
5. Introduction and structure of the document	Introduction aims at explaining, for example, why the community has undertaken an adaptation process and why it is important. It points out the main features of the Local Adaptation Plan and describes the structure of the Plan itself.
6. Vision Statement	It represents a call to action for the community
7. Background & context	Description of the main socio-economic and environmental characteristics of the area; description of the existing adaptation policies and measures.
8. Climate change	Description of current and projected climate change in the area.
9. Impacts, vulnerability and risk	It reports and illustrates the results of the impacts, vulnerability and risk assessment conducted by the Adaptation Team.
10. Objectives and targets	Describes the adaptation objectives and targets for achieving the vision.
11. Adaptation actions	Identifies, lists and describes the adaptation actions selected for achieving the objectives and targets.

Element	Description
12. Implementation schedule	It provides a description of the costs of actions, financial and technical responsibilities, timeline, tools for implementation, potential barriers to the implementation, etc.
13. Additional Information	References, sources of information, etc.

It is important to consider that a LAP is not a static document but a "living" document: the document will not be closed after the development of the LAP, but it will be fed over time by new assumptions, new results, and new lessons learnt.

Once the Team has a draft of the LAP, it will be important to communicate with senior departments, directors and other staff about the LAP and involve them in the preparation of the final draft. Once prepared, the final document will be submitted to the political approval.

Assessment: Checklist for Local Adaptation Plans

Checklist

- ✓ Have you set the appropriate adaptation goals, objectives and targets?
- ✓ Have you identified a portfolio of adaptation options?
- ✓ Have you collected and organized all the relevant information on the adaptation options?
- ✓ Have you defined your own criteria in order to assess, select and priotise the adaptation options?
- ✓ Have you identified cross-sectoral overlap, synergies and conflicts among the adaptation options?
- ✓ Have you prepared a draft of the local adaptation plan?

SESSION 5: ECOSYSTEMS, ECOSYSTEM SERVICES & IMPLEMENTING ECOSYSTEM BASED ADAPTATION

Objective: By the end of this session participants will be able to

- ✓ Identify ecosystem types in their locality
- ✓ Mention ecosystem services derived from different ecosystems
- ✓ Identify threats to different ecosystems
- ✓ Relate threats to ecosystems and human wellbeing
- ✓ Understand the EBA approach
- ✓ Know the benefits of EBA approach

GUIDING TOOL 5:

Steps	Activity	Materials needed	Time
Step 1	Introduction of ecosystem, ecosystem services & EBA	Power Point Project	45minutes
Step 1	Participants identify ecosystem types in their locality and services derived from them – group sessions	Flip Chart	1 hour
Step 2	Participants mention threats to the ecosystem and how they are affected by such threats - group sessions	Calculators	30 minutes
Step 3	Participants point out management strategies for managing the threats to different ecosystems - group sessions	Black board & chalk	45 minutes
Step 4	Participants attempt to fit ecosystems, ecosystem services and well-being into the local adaption plan	Writing books & pens	2 hours

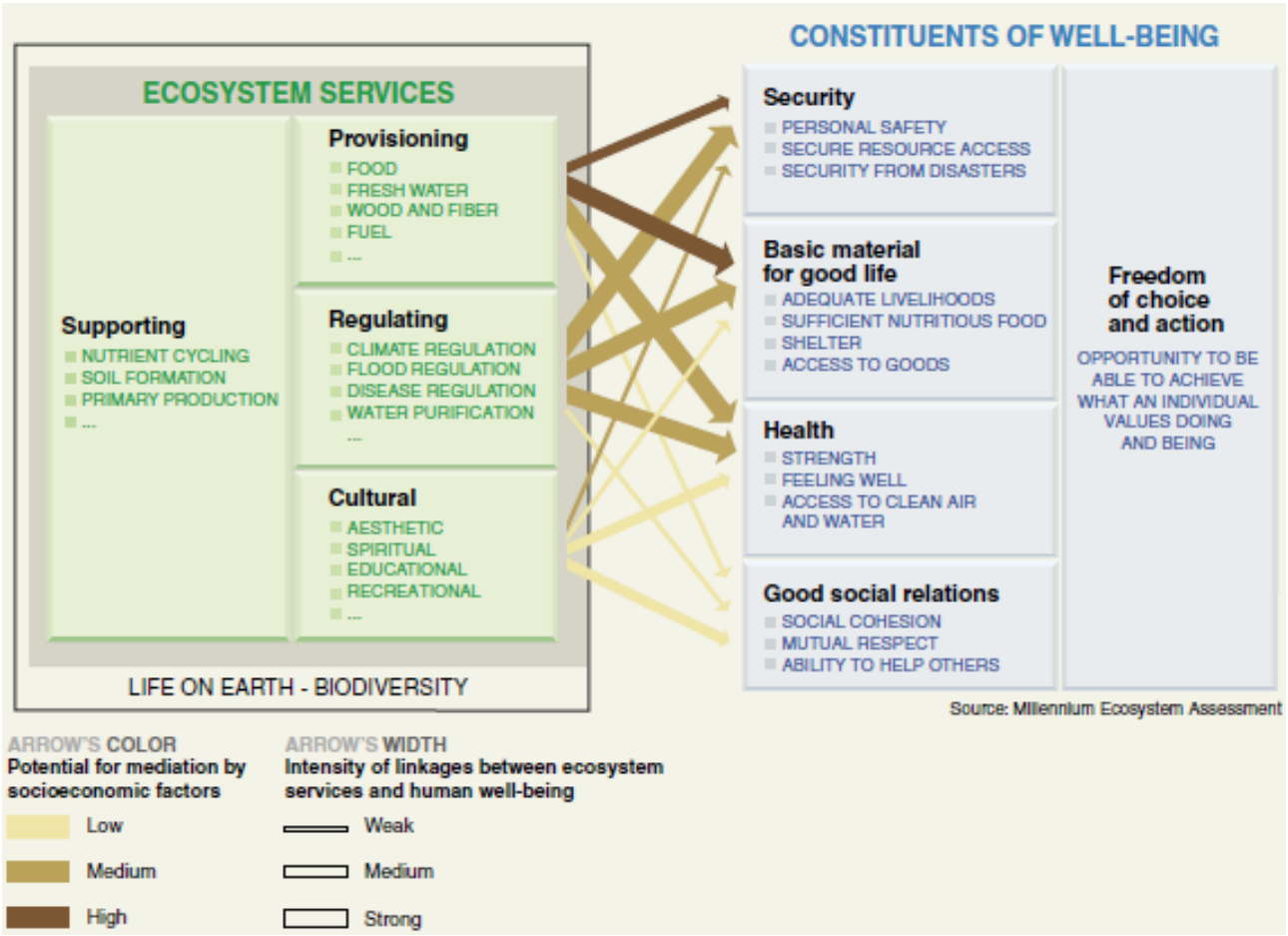
Session Notes

Ecosystem services & ecosystem functioning

Ecosystem services are the benefits that people receive from nature. These benefits include the production of food, the provision of clean water, and the regulation of climate, as well as opportunities for cultural, spiritual and recreational experiences (CCI and Bird Life International 2011).

Figure depicts the strength of linkages between categories of ecosystem services and components of human well-being that are commonly encountered, and includes indications of the extent to which it is possible for socioeconomic factors to mediate the linkage (MA 2005).

Figure 3: Linkages between Ecosystem Services and Human Well-being



Source: UN MA 2005

Ecosystem based adaptation for the Mount Elgon ecosystem looks at building resilience and adaptive capacity for communities affected by the impacts of climate change. Ecosystem services impacts in the Mt. Elgon are largely seen in terms of provisioning, regulatory and cultural services. For example excessive flooding that results in excessive soil erosion, crop and animal loss and loss of human lives in some cases. The crop loss is directly associated with provision services and interruption of cultural services.

Some of the key emerging concepts out of the UN MA process were the recognition that ecosystems could be said to have functions to meet human objectives and values. The concept of ecosystem services, as the benefits people receive from ecosystems, is consistent with this functional view (UN MA 2005). It is also gradually leading to the understanding that ecosystems must be managed within the limits of their "functioning". With functioning in this case referring to how the ecosystem works; i.e. its interactions and processes (UNEP WCMC 2010)

Provisioning Services

These are the products obtained from ecosystems, including: (i) *Food.* This includes the vast range of food products derived from plants, animals, and microbes; (ii) *Fiber.* Materials included here are wood, jute, cotton, hemp, silk, and wool; (iii) *Fuel.* Wood, dung, and other biological materials serve as sources of energy; (iv) *Genetic resources.* This includes the genes and genetic information used for animal and plant breeding and biotechnology; (v) *Biochemicals, natural medicines, and pharmaceuticals.* Many medicines, biocides, food additives such as alginates, and biological materials are derived from ecosystems; (vi) *Ornamental resources.* Animal and plant products, such as skins, shells, and flowers, are used as ornaments, and whole plants are used for landscaping and ornaments; (vii) *Fresh water.*

People obtain fresh water from ecosystems and thus the supply of fresh water can be considered a provisioning service. Fresh water in rivers is also a source of energy. Because water is required for other life to exist, however, it could also be considered a supporting service.

Regulating Services

These are the benefits obtained from the regulation of ecosystem processes, including: (i) *Air quality regulation*. Ecosystems both contribute chemicals to and extract chemicals from the atmosphere, influencing many aspects of air quality; (ii) *Climate regulation*. Ecosystems influence climate both locally and globally. At a local scale, for example, changes in land cover can affect both temperature and precipitation. At the global scale, ecosystems play an important role in climate by either sequestering or emitting greenhouse gases; (iii) *Water regulation*. The timing and magnitude of runoff, flooding, and aquifer recharge can be strongly influenced by changes in land cover, including, in particular, alterations that change the water storage potential of the system, such as the conversion of wetlands or the replacement of forests with croplands or croplands with urban areas; (iv) *Erosion regulation*. Vegetative cover plays an important role in soil retention and the prevention of landslides; (v) *Water purification and waste treatment*. Ecosystems can be a source of impurities (for instance, in fresh water) but also can help filter out and decompose organic wastes introduced into inland waters and coastal and marine ecosystems and can assimilate and detoxify compounds through soil and subsoil processes; (vi) *Disease regulation*. Changes in ecosystems can directly change the abundance of human pathogens, such as cholera, and can alter the abundance of disease vectors, such as mosquitoes; (vii) *Pest regulation*. Ecosystem changes affect the prevalence of crop and livestock pests and diseases; and (viii) *Pollination*. Ecosystem changes affect the distribution, abundance, and effectiveness of pollinators; and (ix) *Natural hazard regulation*. The presence of coastal ecosystems such as mangroves and coral reefs can reduce the damage caused by hurricanes or large waves.

Cultural Services

These are the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences, including: (i) *Cultural diversity*. The diversity of ecosystems is one factor influencing the diversity of cultures; (ii) *Spiritual and religious values*. Many religions attach spiritual and religious values to ecosystems or their components; (ii) *Knowledge systems* (traditional and formal). Ecosystems influence the types of knowledge systems developed by different cultures; (iii) *Educational values*. Ecosystems and their components and processes provide the basis for both formal and informal education in many societies; (iv) *Inspiration*. Ecosystems provide a rich source of inspiration for art, folklore, national symbols, architecture, and advertising; (v) *Aesthetic values*. Many people find beauty or aesthetic value in various aspects of ecosystems, as reflected in the support for parks, scenic drives, and the selection of housing locations; (vi) *Social relations*. Ecosystems influence the types of social relations that are established in particular cultures. Fishing societies, for example, differ in many respects in their social relations from nomadic herding or agricultural societies; (vii) *Sense of place*. Many people value the "sense of place" that is associated with recognized features of their environment, including aspects of the ecosystem; (viii) *Cultural heritage values*. Many societies place high value on the maintenance of either historically important landscapes ("cultural landscapes") or culturally significant species; (ix) *Recreation and ecotourism*. People often choose where to spend their leisure time based in part on the characteristics of the natural or cultivated landscapes in a particular area.

Supporting services are: Ecosystem services that are necessary for the production of all other ecosystem services. Some examples include biomass production, production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and provisioning of habitat (Greenfacts 2005). The core discussion on ecosystem functioning revolves around the supporting ecosystem services.

The functioning of ecosystems can be understood in terms of four core ecosystem processes and how these interact with the structure of the ecosystem and landscape. Management of ecosystem services needs to consider both the necessary ecosystem structure and the functioning of ecosystem processes to supply those services. The four core ecosystem processes that are part of the functioning of ecosystems at all scales are: (i) water cycling; (ii) mineral cycling; (iii) solar energy flow; and (iv) biological growth (UNEP and IISD 2012).

Ecosystem functioning is descriptive of the supporting services of ecosystems. Supporting services are those that are necessary for the production of all other ecosystem services. They differ from provisioning, regulating, and cultural services in that their impacts on people are often indirect or occur over a very long time, whereas changes in the other categories have relatively direct and short-term impacts on people (UN MA 2005). (Some services, like erosion regulation, can be categorized as both a supporting and a regulating service, depending on the time scale and immediacy of their impact on people.) These services include: (i) *Soil Formation*. Because many provisioning services depend on soil fertility, the rate of soil formation influences human well-being in many ways; (ii) *Photosynthesis*. Photosynthesis produces oxygen necessary for most living organisms; (ii) *Primary production* refers to the assimilation or accumulation of energy and nutrients by organisms; (iii) *Nutrient cycling*. Approximately 20 nutrients essential for life, including nitrogen and phosphorus, cycle through ecosystems and are maintained at different concentrations in different parts of ecosystems; and (iv) *Water cycling*. Water cycles through ecosystems and is essential for living organisms.

What is the Ecosystem Based Adaptation Approach?

The Ecosystem-based Adaptation (EbA) approach relates to the management of ecosystems within interlinked social-ecological systems to enhance ecological processes and services that are essential for resilience to multiple pressures, including climate change (UNEP WCMC 2010). Ecosystem-based Adaptation integrates the management of ecosystems and biodiversity into an overall strategy to help people and ecosystems adapt to the adverse impacts of global change, such as changing climate conditions. An optimal overall ecosystem-based strategy will seek to maintain ecological functions at the landscape scale in combination with multi-functional land uses and multi-scale benefits.

The EBA approach depends highly on healthy and resilient ecosystems, which are able to deliver a bundle of ecosystem services to support adaptation and well-being of societies in the face of various pressures that can be internal to the social-ecological system, or external, such as extreme events in the short term or climate change in the longer term (UNEP WCMC 2010).

Strategies within EBA need to consider ways of managing ecosystems for the provision of services that help reducing vulnerability and increasing resilience of socio-ecological systems to both climatic and non-climatic risks, while providing multiple benefits to society and the environment. At the core of this approach lays the recognition of existing interactions and feedbacks between human and ecological systems and the need to optimize these to enhance benefit flows from the system (UNEP-WCMC 2010).

Ecosystem based adaptation is an approach that build resilience and reduces the vulnerability of local communities to climate change. Through considering the ecosystem services on which people depend to adapt to climate change, EBA integrates sustainable use of biodiversity and ecosystem services in a comprehensive adaptation strategy (CBD 2009). This approach suggests that ecosystem-based solutions can contribute to addressing climate change through providing social benefits and ecosystem conservation.

Advantages and priorities of EBA approaches at the landscape level

i) Developing an integrated vision of the land, based on fundamental ecological processes and beyond political-administrative boundaries;

ii) Maintaining the ecological integrity of ecosystems in specific areas that are relevant to ecological services;

iii) Investing in ecosystem based watershed management, soil and vegetation restoration, land use planning and research on farming systems;

iv) Investing in conservation through terrestrial and watershed protected and management areas and through promotion of ecological corridors;

v) Investing in research and monitoring e.g. data gathering ad analysis, particularly related to ecosystem services and functioning, and climate change scenarios;

vi) Improving governance of through local and regional planning processes that integrate the concepts of climate change adaptation;

vii) Developing a vision for climate change adaptation with a vision of the cultural dimension; and

viii) Contributing to public policy development at multiple management levels and scales.

Ecosystem principles in EBA

Just as human rights principles have informed CBA, some key principles on the ecosystem approach to conservation inform EBA. These principles were adopted by the United Nations Convention on Biological Diversity in 2000 and endorsed by the World Summit on Sustainable Development in 2002, and have been in use for the last decade. A subset of ecosystem principles, based on the former, and particularly relevant to EBA, are listed and discussed below in the context of climate adaptation. They fall into four main categories:

1. Maintaining ecosystem services by conserving ecosystem structure and functioning, recognising that ecosystems have limits, undergo change and are interconnected

2. Using appropriate time and spatial scales

3. Ensuring participatory decision-making and decentralised, flexible management; and

4. Using information from all sources including traditional, local and scientific information

Ecosystems function at different scales, from local (for example, the catchment of a small pond) to very large (e.g. an international river basin). Very often their boundaries do not correspond with political boundaries (e.g. village, district, province, or national boundaries).It is important that adaptation planning takes into account and ensures harmonisation between scales of critical ecosystem function and political scales of intervention. Taking a systems approach (a holistic approach that takes into account interactions and interdependencies at different levels) rather than a singular, project-level approach –integrating local planning with broader river basin planning, for example–will likely yield better, long-term results.

Similarly, it can take time for climate impacts on ecosystems to manifest themselves. EBA also takes temporal aspects into account, supporting adaptation to both current and future climate conditions, and promotes "no-regrets" strategies that make sense and provide tangible benefits with or without the impact of climate change. Participatory learning as well as monitoring and evaluation with feedback to a flexible management system (PLM&E) are, in this sense, very important for adaptation to be grounded in best practice.

The closer management is to the ecosystem, the greater the responsibility, ownership, accountability, participation, and use of local knowledge. EBA should therefore be decentralised to the lowest appropriate level, avoiding top-down approaches that may not take local interests fully into account, and ensuring that responses are culturally appropriate. EBA should also encourage gender-sensitive, community engagement–which is a very important aspect given the particular vulnerability of women and their high dependence on ecosystem services in resource poor communities. Moreover, in many communities, women play an important role in natural resource management.

Climate adaptation will inevitably involve trade-offs as demand and competition for natural resources and ecosystem services increase (due to factors such as ongoing climate change, resource use, economic growth, globalization, migration and globalisation, as well as population growth), and environmental change continues unabated. Such trade-offs will vary depending on the given context. While EBA does not provide a way to avoid difficult choices, if appropriately applied, it can help in some cases to identify options that maximize longer-term benefits. Adaptation decisions should therefore be based on risk assessment, scenario planning and adaptive management approaches that recognise and incorporate these potential trade-offs, seeking to obtain a sound balance between human and ecosystem concerns, and fair conflict resolution among different stakeholders. It can also help to promote participatory decision-making, ensuring that the needs of poor and vulnerable people are heard as well as to larger economic interests, which can result in more equitable benefits sharing.

Under EBA, local communities and indigenous people can contribute valuable traditional knowledge and practices for adaptation, based on their past experience of coping with climate variability, that can be applied–with full participation and free prior and informed consent–to current adaptation with good effect. This includes, for example, using local crop varieties and cultivation methods that can withstand extreme weather conditions, and locally appropriate methods to store seed stocks. At the same time, some of the changes that are being experienced now by local communities and are most likely in the future, go beyond living memory and adapting to them may require technological solutions that come from outside the communities. Local observation of changes in weather, hazards and impacts, along with scientific projections of future changes and scenario planning, can contribute to assessing current and future vulnerability and planning responses.

Benefits of Ecosystem based Adaptation

Ecosystem-based Adaptation reduces vulnerability to both climate and non- climate risks and provides multiple economic, social, environmental and cultural benefits, including;

i) **Disaster risk reduction**
   Ecosystem-based Adaptation measures frequently complement disaster risk reduction objectives. Healthy ecosystems play an important role in protecting infrastructure and enhancing human security, acting as natural barriers and mitigating the impact of (and aiding recovery from) many extreme weather events, such as flooding, droughts, extreme temperatures, fires and landslides.

ii) **Livelihood sustenance and food security**
   By protecting and restoring healthy ecosystems to be more resilient to climate change impacts, Ecosystem based Adaptation strategies can help to ensure continued availability and access to essential natural resources so that communities can better cope with current climate variability and future climate change. In this context, Ecosystem-based Adaptation can directly meet the needs of Community Based Adaptation and poverty reduction initiatives.

iii) Biodiversity conservation

Protecting, restoring, and managing key ecosystems helps biodiversity and people to adjust to changing climatic conditions. Ecosystem-based Adaptation can safeguard and enhance protected areas and fragile ecosystems. It can also involve restoration of fragmented or degraded ecosystems, or simulation of missing ecosystem processes such as migration or pollination.

iv) Carbon sequestration

Ecosystem based Adaptation strategies can complement and enhance climate change mitigation. Sustainable management of forests can store and sequester carbon by improving overall forest health, and simultaneously sustain functioning ecosystems that provide food, fibre and water resources that people depend on. Conservation and, in some cases restoration, of peat lands can protect very significant carbon stores. Additional mitigation efforts can be realized through land and water management practices that sustain essential natural resources while minimizing additional greenhouse gas emissions.

v) Sustainable water management

Managing, restoring and protecting ecosystems can also contribute to sustainable water management by, for example, improving water quality, increasing groundwater recharge and reducing surface water run-off.

EBA Approach in Uganda's Mount Elgon Ecosystem

The goal of the EBA project in Uganda is to strengthen Uganda's capacity for promoting ecosystem based adaptation options and to reduce vulnerability of communities to climate change with particular emphasis on mountain ecosystems. The EBA project in Uganda is divided into four components. They are (i) development of methodologies and tools for EBA decision-making in the targeted Districts in the Mount Elgon Ecosystem; (ii) application of methodologies and tools in targeted Districts; (iii) implementation of EBA pilots in targeted Districts; and (iv) development of a business case for EBA at the national level.

The EBA approach delivers specific outcomes and outputs based on set objectives, referred to as project components. The output described in the Table are important at different levels; at the landscape level the important considerations is development of tools, their application and implementation objectives 1 to 3. For District Local Governments and extension staff, participation in all three phases is important. Similarly, Civil Society Organisatons (CSOs) will be keen to participate at all levels. However, farmers and farmers' organisations will be mainly interested to participate in implementation of tools and methods that have been proven to lead to an improvement of adaptation, adaptive capacity and livelihoods.

At the national level, stakeholders will be interested in the success of all stages; but most fundamentally for the potential to scale the successes from one landscape to others. Scaling up of successful EBA options also extends to actions within the landscape that were limited to only a few local level stakeholders even when the potential beneficiaries are many more.

Table 8: Project components, expected outcomes and expected outputs

Project components	Expected outcomes	Expected outputs
1. Development of methodologies and tools for EBA decision making in the targeted Districts in the Mount Elgon Ecosystem	Methodologies and tools for EBA decision-making developed	Output 1.1: good practice EBA options identified and compiled
		Output 1.2: improved methods & tools for climate change vulnerability impact assessment (VIA) for EBA to support the design of EBA options developed
2. Application of methodologies and tools in targeted Districts in the Mount Elgon Ecosystem	EBA methodologies & tools applied	Output 2.1: climate change vulnerability impact assessment undertaken
		Output 2.2: EBA strategy identified using decision-making tools, including an economic assessment of EBA options & land use plans
3. Implementation of EBA pilots in targeted Districts in the Mount Elgon Ecosystem	EBA pilot projects implemented & contributing towards ecosystem resilience & reduction of livelihood vulnerability in the face of climate change impacts	Output 3.1: institutional roles & responsibilities for EBA agreed by different stakeholders at all levels.
		Output 3.2: institutional capacity of local governments and other key national institutions to plan, monitor and enforce EBA enhanced
		Output 3.3: pilot projects focusing on water resources management & enhancement of soil conservation measures implemented
		Output 3.4: market opportunities & access enhanced
		Output 3.5: lessons learned from pilot projects captured & disseminated
4. Development of a business case for EBA at the national level	Business case for EBA at the local & national levels developed	Output 4.1: enabling environment for scaling-up EBA at the national level as part of climate risk management strategy created
		Output 4.2: key government stakeholders have the information available and capacities to integrate EBA into national development planning processes and climate policies and strategies.

Institutions implementing EBA in Uganda & internationally

The institutional arrangements and roles for implementation of the EBA project in Uganda (Table 2) delineates the present arrangements that would likely change based on national level adoption of EBA approaches. Nonetheless, it is worthwhile noting that the EBA projects has an international governance mechanism under the Global Steering Committee

Table 9: Institutions, roles and responsibilities in implementation of EBA project

Institutions	Roles and responsibilities
Global Steering Committee	• to provide strategic guidance to the project at the global level. • provide input as regards up-scaling • assist in resource mobilization
National Steering Committee	• will provide guidance to project implementation in Uganda • ensure the high level support and participation of key stakeholders both at national and district levels
UNEP	• provide overall coordination of the project at the global level in close collaboration with UNDP and IUCN • through UNEP-WCMC shall implement project activities in components 1 and 2 of the project • provide the lead technical role for components 1 & 2
CSOs	• will work through coordination structures described in this section to ensure that project implementation proceeds in a coordinated manner.
IUCN & UNDP	• will jointly provide the lead technical role on Component 3
UNDP	• will provide the lead technical role on Component 4
National Coordination Team	• provide leadership in day to day management of the project in Uganda • directly supervise those activities contracted to consultants
District Local Government	• Integrate lessons into the local district development plans

Group exercise

Group I: Forests

Goods and services derived from the ecosystem	Threats to ecosystem	Impacts to human well-being	Means of dealing with threats to ecosystem	Responsible organization/ persons

Group II: Agro-ecosystem

Goods and services derived from the ecosystem	Threats to ecosystem	Impacts to human well-being	Means of dealing with threats to ecosystem	Responsible organization/ persons

Group III: Fresh water

Goods and services derived from the ecosystem	Threats to ecosystem	Impacts to human well-being	Means of dealing with threats to ecosystem	Responsible organization/ persons

SESSION 6: IMPLEMENTING SOIL & WATER CONSERVATION - EBA IN THE MT. ELGON ECOSYSTEM

Objective: At the end of this session participants will be able to

i) Define soil erosion, soil conservation and water conservation and describe factors causing soil erosion

ii) Introduce and describe the soil erosion management practices for the EBA in the Mt. Elgon ecosystem

iii) Describe elements of design and implementation of the soil erosion management practices

iv) Set up demonstrations for the soil erosion management practices as well as learning from existing practice within the area

Questions

i) What is soil erosion, what is soil conservation? What is water conservation?

ii) What type of soil erosion management practices or soil conservation practices are feasible within the Mt. Elgon and why?

iii) What soil conservation practices are being implemented under the EBA project?

iv) What is your level of understanding and practice of the EBA soil conservation practices?

GUIDING TOOL 6

Steps	Activity	Materials needed	Time
Step 1	Define soil erosion, soil conservation and water conservation and describe factors causing soil erosion	Power Point Project	1 hour
Step 1	Introduce and describe the soil erosion management practices for the EBA in the Mt. Elgon ecosystem	Flip Chart	1 hour
Step 2	Describe elements of design and implementation of the soil erosion management practices	Calculators	1 hour
Step 3	Setup demonstrations for the soil erosion management practices as well as learning from existing practice within the area	Black board & chalk	2 hours
Step 4	Participants attempt to implement soil conservation and water conservation practices on their land	Writing books & pens	2 hours

SESSION NOTES

What is soil erosion?

Soil erosion is a phenomenon that happens when soil is washed by rain, run-off water or waves, blown by wind or affected by gravity or drastic temperature variation. Because of the factors (influences or causes) soil structure disintegrates (breaks-up) and soil particles become detached. Eventually the particles will be carried away and deposited at another location.

Factors that cause soil erosion

There are many elements that influence the process of soil erosion. These factors include climate, topography, vegetation, soil texture and human behaviour. The relationship between these factors is illustrated in Figure 4 below.

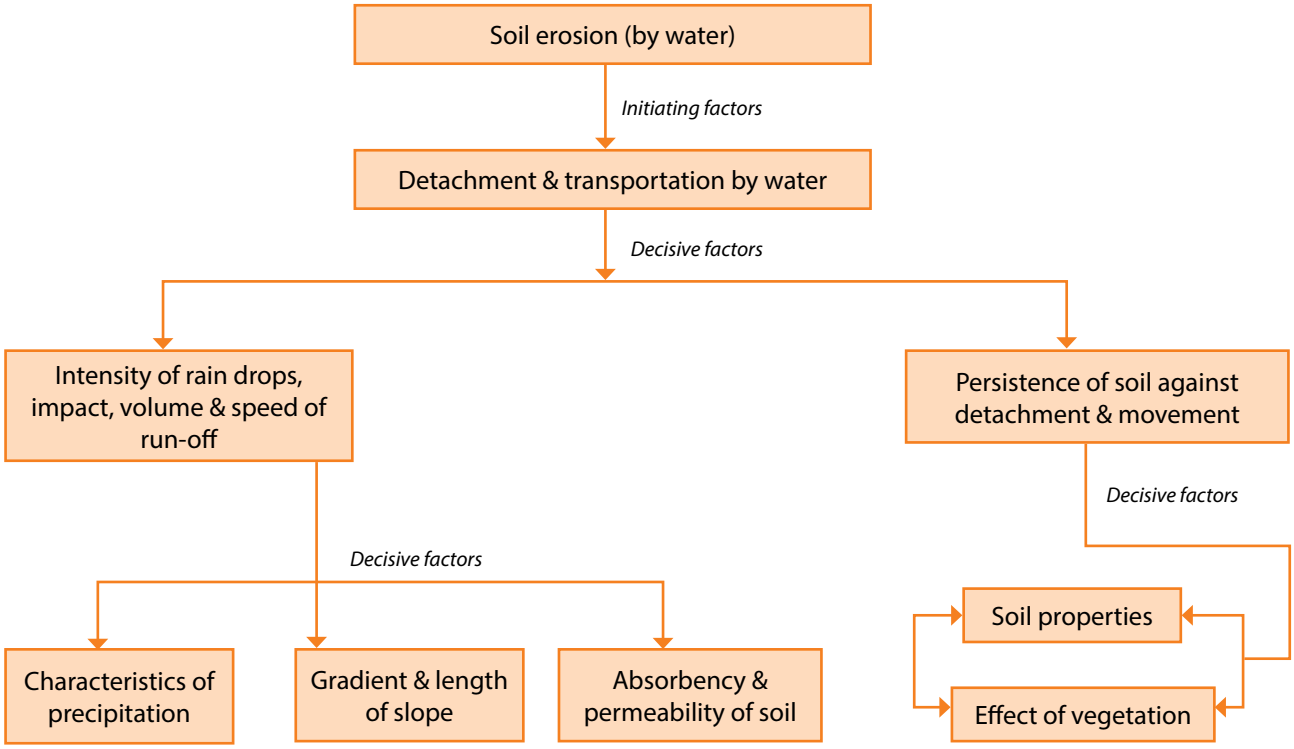


Figure 4: correlation of various factors involved in soil erosion

What is soil conservation?

It is the prevention and reduction of the amount of soil lost through erosion. It seeks to increase the amount of water seeping into the soil, reducing the speed and amount of water running off. Erosion is prevented by keeping enough vegetation to protect the soil surface and binds the soil together and maintains soil structure.

What is water conservation?

This is a way of tapping as much water as possible and storing it in tanks or reservoirs. It allows water to sink into the soil increasing soil moisture levels. It ensures a protective cover of vegetation on the soil surface, slowing down the flow of running water and spreads the water over a large area.

Farm land soil conservation

There are several measures of farmland soil conservation. They are grouped around seven categories of; (i) engineering solutions, (ii) agronomic solutions, (iii) road design for soil conservation, (iv) drainage, (v) erosion damage control, (vi) irrigation systems for slope lands, (vii) soil conservation oriented planning. The main focus for the EBA project in the Mt. Elgon ecosystem is a simple engineered solution and the complementary agronomic and vegetative measures.

Plate 1: Site of gulley erosion and landslides in Bulambuli District

Plate 2: Area that would be suitable for soil and water conservation practices

Hill side Ditches

Definition

Hillside ditches are a series of shallow ditches built along the contour lines of a hill slope at proper intervals.

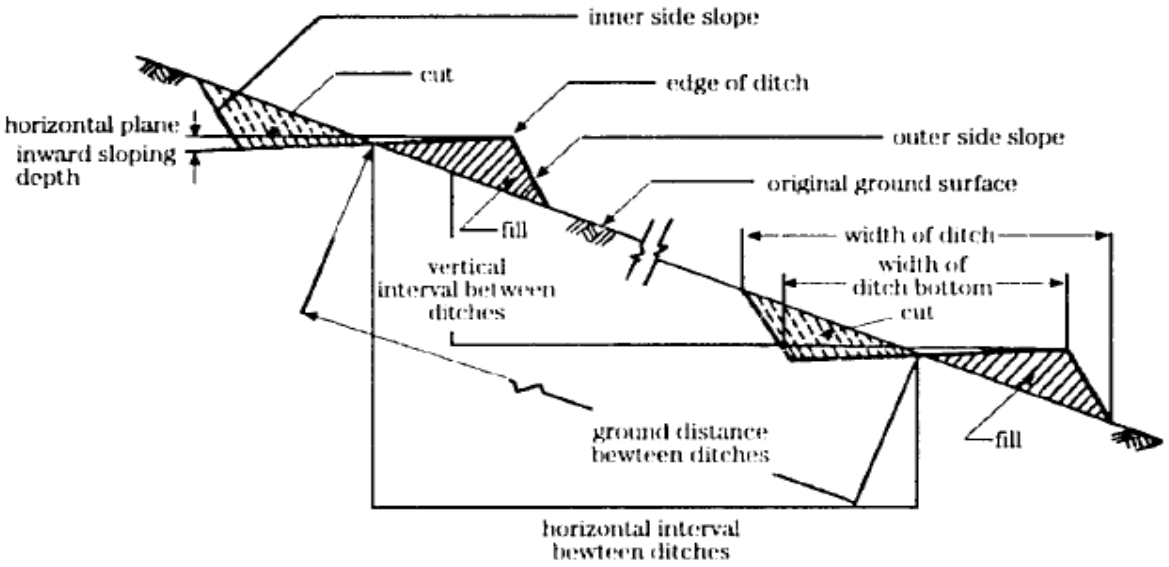
Objectives

i) To break-up a long slope into short slopes in order to intercept run-off water

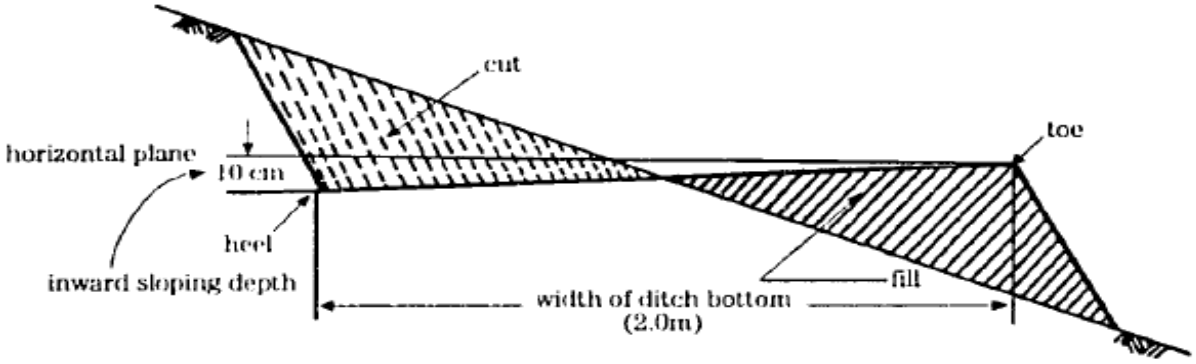
ii) The ditches may also serve as farm paths to facilitate transportation in that the operating costs may be reduced

Diagram

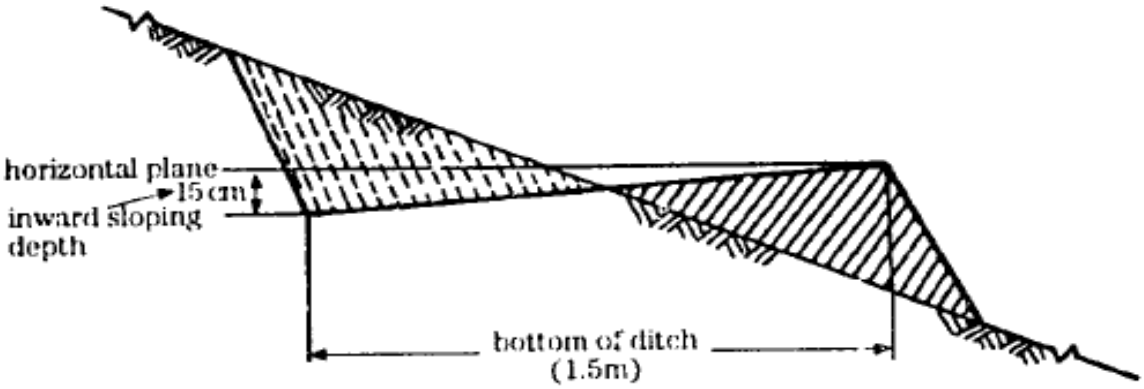
Cross section



Broad type



Narrow type



Source: Food and Fertiliser Technology Centre for the Asian and Pacific Region (1995)

Application

i) Suitable for slopes of less that 40% gradient

ii) In some cases outward type hillside ditches may be used on slopes greater than 40%

iii) Suitable for slopes of up to 55% on tree farms and pasture lands provided the slope s are covered in vegetation

In the Mt. Elgon the steep slopes are used for cultivation of annual crops. Therefore hill side ditches are likely to be popular; however, the vegetation cover as well complementary practices will be needed to increase the feasibility.

Practice session: Design

i) Spacing: the spacing metres between ditches is determined by the following formula

$$VI = \frac{S + 6}{10}$$

$$HI = \frac{VI}{S} x100 = \frac{S + 6}{S} x10$$

VI- vertical interval between ditches (m)
S- Gradient %
HI- horizontal interval between ditches (m)

The spacing can be adjusted within a range of +/-25% depending on permeability of the soil and the degree of soil erosion, the type of crops being grown and the types of farming practices being employed.

i) Selection of type: the broad type (2 metres at the bottom) is used for gentile slopes while the narrow type (1.5 metres at the bottom) is suitable for steeper slopes.

ii) Gradient: the gradient of the ditch should be 1-1.5% in principle, when necessary it may be extended to 5%.

iii) Length: the length of the ditch should be no more than 100 metres if the ditch drains in one direction. When a ditch is longer than 100 metres, the drainage water should be directed to both ends or to the centre of the ditch.

iv) Drainage: normally water in the hillside ditches drained by waterways built along the sloes where the waterway and the hillside ditches meet, the bottom of the waterway should be built into a shallow curve and paved with bricks or stones or planted with grasses to facilitate passing of farm machinery on wheels. A small culvert may be installed instead when necessary.

v) Outlet: At the outlet, the width & the gradient of the ditch should be increased. The junction between the hillside and the waterway should be even and smooth

vi) Grass planting: grasses should be planted on the bottom and side slopes of the ditches

Complementary treatments

i) Diversion or interception ditches

ii) Contour planting, cover cropping and/or mulching

iii) Planting grass cover in ditches

iv) Appropriate drainage

Maintenance

i) Inspect ditches before and after the rainy season and repair any damage immediately

ii) Remove debris & sediment from ditches

Plate 3: Potential site for hillside ditches

Bench Terraces

Definition

A series of level or nearly level platforms built along contours at suitable intervals.

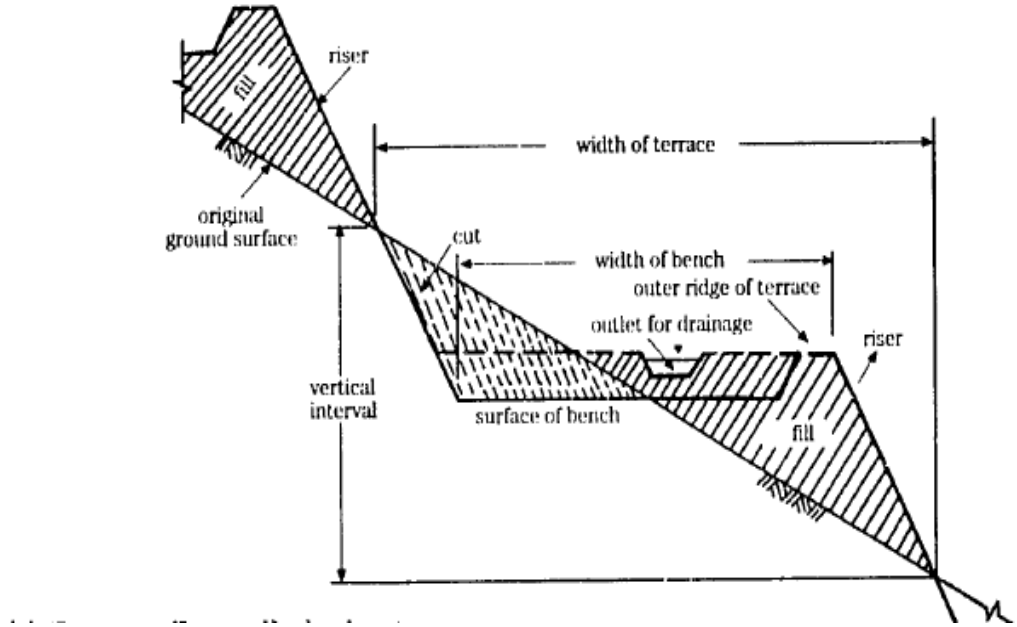
Objectives

i) To intercept runoff and control soil erosion.

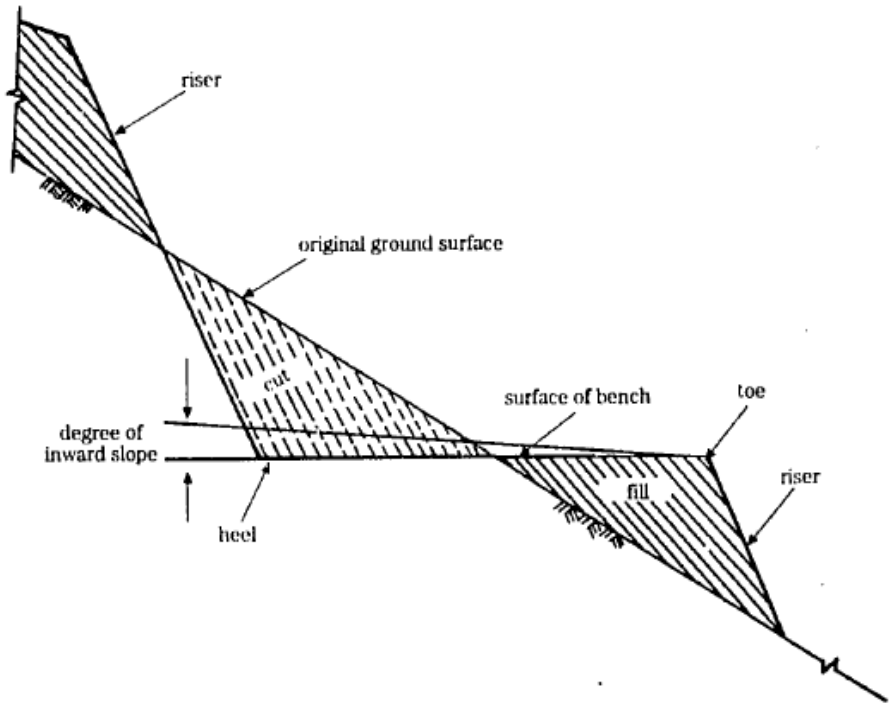
ii) To make cropping operations possible and safe on slopeland.

Diagrams

(1) Level and retention type

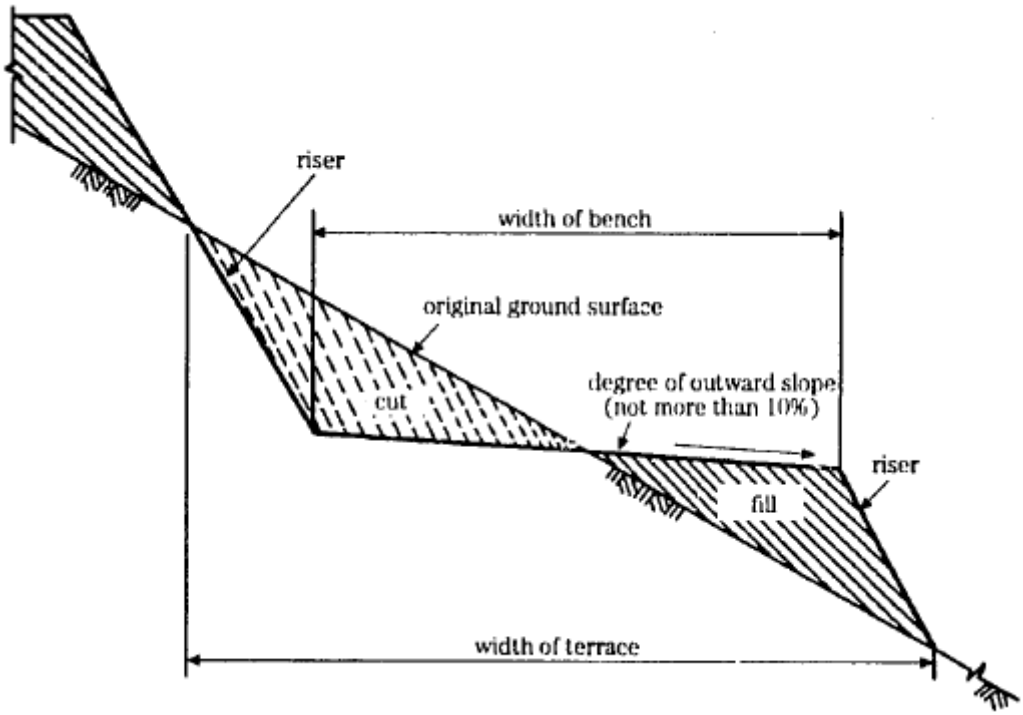


(2) Reverse (inward) sloping type



Source: Food and Fertiliser Technology Centre for the Asian and Pacific Region (1995)

(3) Reverse (outward) sloping type



Source: Food and Fertiliser Technology Centre for the Asian and Pacific Region (1995)

Application

iii) Suitable for steep sloping farmland with considerable depth of soil. This erosion control practice is adopted to facilitate specific crop management systems and the operation of farm machinery.

iv) Suitable for steeper slopes where intensive cultivation is practiced.

v) Usually, outward-sloping type bench terraces should be used with hillside ditches.

vi) When erosion can be controlled by less costly measures, construction of bench terraces should be avoided.

Design

vii) Bench Width: Depending on the gradient of slope, depth of soil, crops and types of farm machinery used. The width of an outward-sloping bench terrace normally should not exceed half of the distance between hillside ditches.

viii) Riser: The upper riser-slope ratio is 1 : 0.5 and the lower riser slope ratio is 1 : 1-0.5. However, adjustments may be made depending on soil type and whether the risers will be covered with grass or faced with stone. The outward sloping bench should be provided with dense grass cover.

ix) Vertical-interval: The vertical interval between benches may be calculated by the following formulas:

Level type

$$VI = \frac{(W.S)}{100 - (s.\mu)} = \frac{(W.{}^{S}/_{\mu})}{{}^{100}/_{\mu - S}} = \frac{d.S}{100}$$

Inward type

$$VI = \frac{(W.S + k.S.\mu)}{100 - (s.\mu)} = \frac{(W.{}^{S}/_{\mu + k.S})}{{}^{100}/_{\mu - S}} = \frac{d.S}{100}$$

Outward type

$$VI = \frac{(W.S + k.S.\mu)}{100 - (s.\mu)} = \frac{(W.{}^{S}/_{\mu + WzS})}{{}^{100}/_{\mu - S}} = \frac{d.S}{100}$$

VI =vertical interval (m)

W =width of bench (m)

S = slope of original surface *(%)*

d =width of terrace (ni)

k = difference in height between front and back of bench (in the case of inward-sloping and outward-sloping benches) (in)

z = slope of the outward-sloping bench (vertical: horizontal ratio)

μ = slope ratio of riser (vertical: horizontal = l:μ)

x) Width: The width of the bench terrace must fit in with crop spacing and mechanized operations.

Level type

$$d = \frac{100VI}{S} = W + VI.S$$

Outward-sloping and inward-sloping types

$$d = \frac{100VI}{S} = W + \left(VI \pm k\right)\mu = W + (VI \pm W.z)\mu$$

Note: k and z are positive figures for reverse-slope type benches and negative for the outward-slope type

v) Gradient: The gradient should be 0.5% to 1%for the inward type of bench, while that of the outward type is the same as for hillside ditches.

vi) Length: The length of a bench terrace should not exceed 100 in when water running along the bench is drained in only one direction.

vii) Height of the reverse slope: On reverse-sloping benches, the height of the toe above the heel should be more than **10** cm once the soil is well settled. When the width of the bench exceeds 3 m, the difference in height may be reduced to 5 cm.

viii) Outward slope: On outward-sloping benches, the outward slope should be less than 10%.

ix) Bench ridge: A bench ridge is built along the outer edge of level type terraces. This ridge should be 20 cm in height and 20 cm in width at-the top.

x) Outlet: For level type terraces, a water outlet about 10 cm deep and 20 cm wide should be constructed at the ridge to drain water into the waterway.

Maintenance and management

xi) Upon completion of the terraces, it is advisable to deep plough the part of the ground, which has been cut, and apply soil amendments if necessary.

xii) The cross-section of the terraces must be maintained in good order when the crops are being grown. If any damage occurs it must be repaired immediately.

xiii) The grass on the risers must be properly managed to maintain a good cover.

Plate 4: Bench terrace practice in the Mt. Elgon Ecosystem

Grass planting on hill side ditches

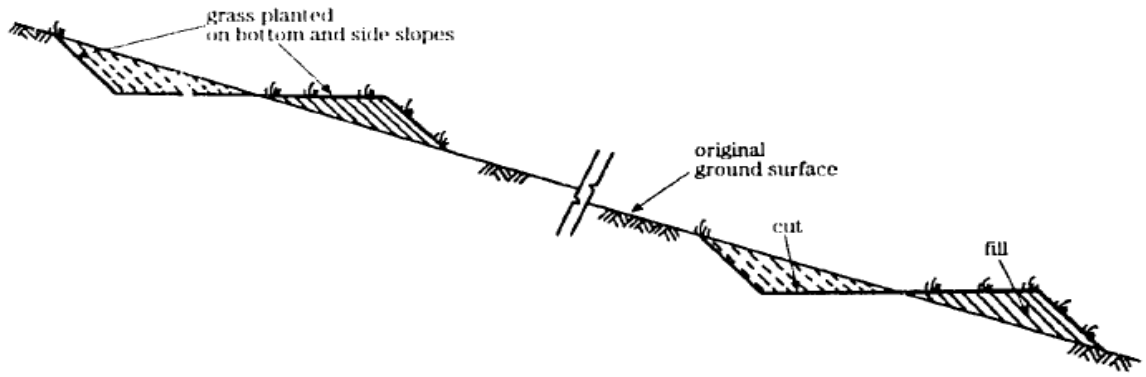
Definition
Grass planting on hillside ditches refers to the establishment of specific grasses on hillside ditches, including both the bottom and side slopes of each ditch

Objectives
i) To stabilise the hillside ditch and thus reduce maintenance costs

ii) To save the labour costs of weeding

iii) To prevent soil erosion on the upper side slow of the ditch and to gradually reduce the slope as sliding soil is trapped by the grass

Diagram



Application
i) Cover for the ditch including carpet grass (*Axonopus compressus & A. affinis*), Bermuda grass (*Cynodon dactylon*), Bahia grass (*Paspalum rotatum*), centipede grass (*Erenchloa opiurodes*) and sour grass (*Paspalum conjugatum*) are generally suitable, while indigenous creeping grasses are also useful.

ii) For protection of the side-slopes and the edge of the ditch Bahia grass is recommended at a spacing of 30cm x 30 cm.

iii) Planting of Bermuda grass may be done by spreading the grass cuttings on the ground and covering them with soil and then compacting the soil.

Operational procedures
i) Planting should be done as soon as the ditch construction is completed.

ii) If grass sprigs are used, they should be planted individually in dense triangle patterns

iii) If seeds are used, hydro-seeding and the vegetation belt are recommended methods

Management
i) Inhabitation of rodents should be prevented

ii) Thorough vegetation cover should be maintained, replanting should be done without delay when wilting or damage of any part of the grass takes place. Fertiliser (manuring) should be applied when necessary

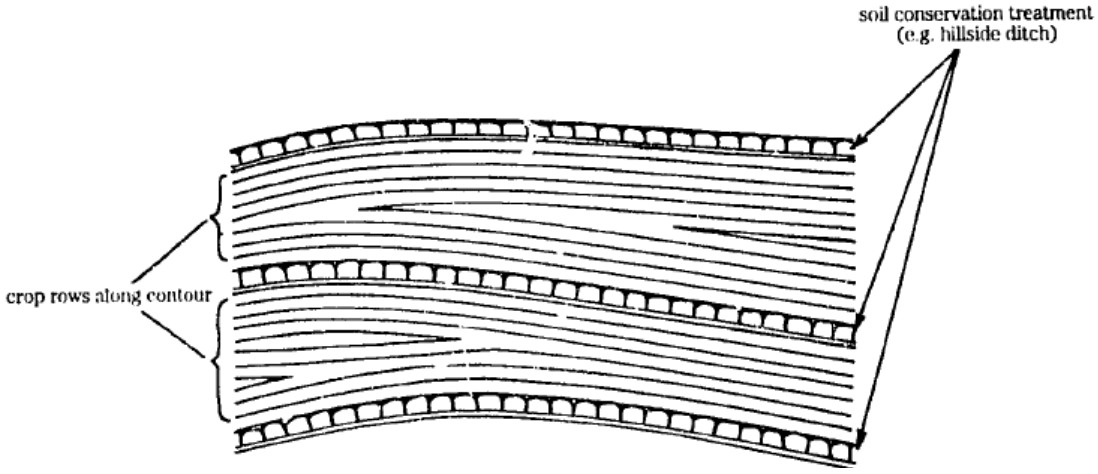
Contour planting

Definition
Contour planting is ploughing, furrowing and planting along the contour lines of a slope.

Objectives
i) To increase water penetration into soil and conserve soil moisture

ii) To control run off and soil erosion

Diagram



Application
This practice should be adopted wherever crops are grown on slope land

Operational procedures
i) When hillside ditches exist, they should be used as a guideline for ploughing, furrowing and other cultivation

ii) The most adequate number of long the guideline is four to six.

iii) Short rows should be positioned in the middle between guidelines

Maintenance
Repair any damage which may occur during heavy rains as soon as possible.

Cover crops

Definition
Cover crops are plants which are grown to cover the surface of the ground with dense foliage to control soil erosion and improve the soil.

Objectives
i) To protect the surface from the splash of raindrops

ii) To build up soil organic matter and improve its physical and chemical properties

iii) To suppress weed growth and reduce management costs

iv) To minimise changes in microclimate and soil temperature, thereby providing a better environment for crop growth

Application
i) Mainly for tree crops in combination with soil conservation treatment

ii) When grass is planted as a cover crop, the chosen species should be proven to have soil conservation value.

Green manure

Definition
Green manure crops are grown specifically to improve soil and act as a fertiliser. The crops are ploughed into soil while still green or shortly after they have matured.

Objectives
i) To increase organic matter and nutrients in soil.

ii) to improve the physical and chemical characteristics of soil to increase the resistance to soil erosion.

Application
i) green manure crops may be grown to improve sandy soils, heavy clay and every type of unproductive soil.

ii) They may be grown in between rows of an existing crop or on land lying fallow before a commercial crop is planted.

Design
i) Select green manure crops adaptable to the local conditions

ii) Characteristics include, easy to raise, fast growing, high yielding, high nutrient content and not adverse to the main crops

iii) Examples are Sesbania, Desmodium, Alfa alfa, velvet bean etc.).

Mulching

Definition
A protective covering of grass, crop residue or material spread over the ground between crop rows or around the trucks of trees

Objective
i) To reduce run-off and soil loss

ii) to increase soil moisture

iii) To suppress weeds and save labour of weeding

iv) To adjust soil temperature

v) To increase soil organic matter

vi) To reduce evaporation of soil moisture

Application
i) Where runoff losses are high

ii) When an increase in soil organic matter, reducing evaporation, suppression of weeds or adjustment of soil temperature are needed

iii) When polyethylene is used as mulch it will only achieve some of the above objectives

Operational procedures

i) Cover crops or grasses used in fields should be readily available sources of mulching material

ii) Polyethylene sheets and other artificial material may be used with limited suitability

Essential points to consider

i) Mulch should be avoided if it increases spread of pests and diseases or could be a possible fire hazard.

ii) When polyethylene is used for mulch, runoff will increase.

iii) Large pieces of crop residue should be broken down or cut up before application.

iv) When organic materials are used the mulch should not be too thick.

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ANNEXES: GLOSSARY

Adaptation deficit: A failure to adapt to current climatic conditions because of a low level of development (for example, inadequate housing structures to deal with extreme weather, a lack of access to credit for investing in new crop varieties, or limited technical expertise to manage a natural buffer to the effects of sea level rise).

Adaptation gap: A failure to take action to address issues that arise as a consequence of existing or anticipated climate variability and change (for example, being better equipped to deal with extreme weather events, having buffers against droughts, and dealing with changes in cropping patterns resulting from temperature rise).

Adaptive capacity: Potential or capability of a system to adjust to climate change, including climate variability and extremes, so as to moderate potential damages, to take advantage of opportunities, or to cope with consequences.

Benefits: Positive change in well-being from the fulfillment of needs and wants.

Biodiversity (a contraction of biological diversity): The variability among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part. Biodiversity includes diversity within species, between species, and between ecosystems.

Climate proofing: Identifying risks to development interventions, or any natural or human asset, as a result of climate change and climate variability, and ensuring that those risks are reduced to acceptable levels. Climate proofing is meant to improve the likelihood of sustaining intervention results and helps improve adaptation strategies that can better inform adjustments to interventions.

Cultural services: The nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience, including, e.g., knowledge systems, social relations, and aesthetic values.

Decision-maker: A person whose decisions, and the actions that follow from them, can influence a condition, process, or issue under consideration.

Ecosystem services: The benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services such as nutrient cycling that maintain the conditions for life on Earth. The concept "ecosystem goods and services" is synonymous with ecosystem services (MA 2005). This MA typology provides one definition and classification scheme but, for the purposes of economic analysis, ecosystem services may also be defined as the direct and indirect contributions of ecosystems to human well-being.

Effectiveness: The extent to which an intervention's objectives have been , or are likely to be, achieved.

Evaluation: Evaluation is the objective assessment of an on-going or completed set of activities, such as a project or program, according to its design (initial plans), implementation (execution, outputs) and results (outcomes, impacts).

Exposure: The extent to which people, property, or systems are in a hazard zone and subject to harm or loss. Measures of exposure can include the number of people or types of assets in an area. These can be combined with the specific vulnerability of the exposed elements to any particular hazard to estimate the quantitative risks associated with that hazard in the area of interest.

Maladaptation: Exacerbating climatic pressures or effects, including increasing greenhouse gas emissions, disproportionately burdening vulnerable populations, causing high opportunity costs for actions taken, reducing incentives to adapt, or causing path dependency by narrowing or eliminating future options.

Management (of ecosystems): An approach to maintaining or restoring the composition, structure, function, and delivery of services of natural and modified ecosystems for the goal of achieving sustainability. It is based on an adaptive, collaboratively developed vision of desired future conditions that integrates ecological, socioeconomic, and institutional perspectives, applied within a geographic framework, and defined primarily by natural ecological boundaries.

Monitoring: Monitoring is systematic observation and collection of data on the progress or quality of something, such as tracking the number and gender of workshop participants, measuring annual growth of saplings, or counting the number of new sector policies that account for or address climate change.

Provisioning services: The products obtained from ecosystems, including, for example, genetic resources, food and fiber, and fresh water.

Regulating services: The benefits obtained from the regulation of ecosystem processes, including, for example, the regulation of climate, water, and some human diseases.

Resilience: The capacity of a system to experience shocks while retaining essentially the same function, structure, feedbacks, and therefore identity. This could be determined by the degree to which the social system is capable of organizing itself to increase capacity for learning from past events for better future protection and to improve risk reduction measures.

Resilience: The level of disturbance that an ecosystem can undergo without crossing a threshold to a situation with different structure or outputs. Resilience depends on ecological dynamics as well as the organizational and institutional capacity to understand, manage, and respond to these dynamics.

Scale: The measurable dimensions of phenomena or observations expressed in physical units, such as meters, years, population size, or quantities moved or exchanged. In observation, scale determines the relative fineness and coarseness of different detail and the selectivity among patterns these data may form.

Sensitivity: The extent to which a system is affected—positively or negatively—by climate variability and climate change Measures may include bio-physical effects that can be altered by socio-economic factors.

Supporting services: Ecosystem services that are necessary for the production of all other ecosystem services. Some examples include biomass production, production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and provisioning of habitat.

Sustainability: A characteristic or state whereby the needs of the present and local population can be met without compromising the ability of future generations or populations in other locations

to meet their needs.

Sustainable flow (of ecosystem services): The availability of ecosystem services to yield a continuous benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations.

Sustainable use (of ecosystems): Using ecosystems in a way that benefits present generations while maintaining the potential to meet the needs and aspirations of future generations.

Trade-offs: Management choices that intentionally or otherwise change the type, magnitude, and relative mix of services provided by ecosystems.

Value: The contribution of an action or object to user-specified goals, objectives, or conditions.

Vulnerability: The degree to which a system is susceptible to, and unable to cope with, the adverse effects of climate change, including climate variability and extremes. A function of the exposure, magnitude, and rate of climate change and variation to which a system is exposed, as well as its sensitivity and adaptive capacity.

Well-being: A context- and situation-dependent state, comprising basic material for a good life, freedom and choice, health and bodily well-being, good social relations, security, peace of mind, and spiritual experience (MA 2005).

Comments

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