Natural Resource Conservation and Development-III

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Module Title: Applying Watershed Management Core Principles

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LG #58	**LO1: Identify and Describe Basic Watershed Processes and their Interrelated Nature**

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Delineating critical and micro/sub watersheds
- Identifying and describing natural processes
- Identifying and describing human factors
- Describe size of the watershed, population, current land uses
- Selecting materials

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Delineate critical and micro/sub watersheds with the consent of the communities and other concerned parties involved
- Identify and describe natural processes at work in the watershed area
- Identify and describe Human factors at work in the watershed
- Enumerate and describe size of the watershed, population, current land uses by percentages, kebeles in the watershed.
- Select materials are to complete proposed works.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets”
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1- Selecting materials

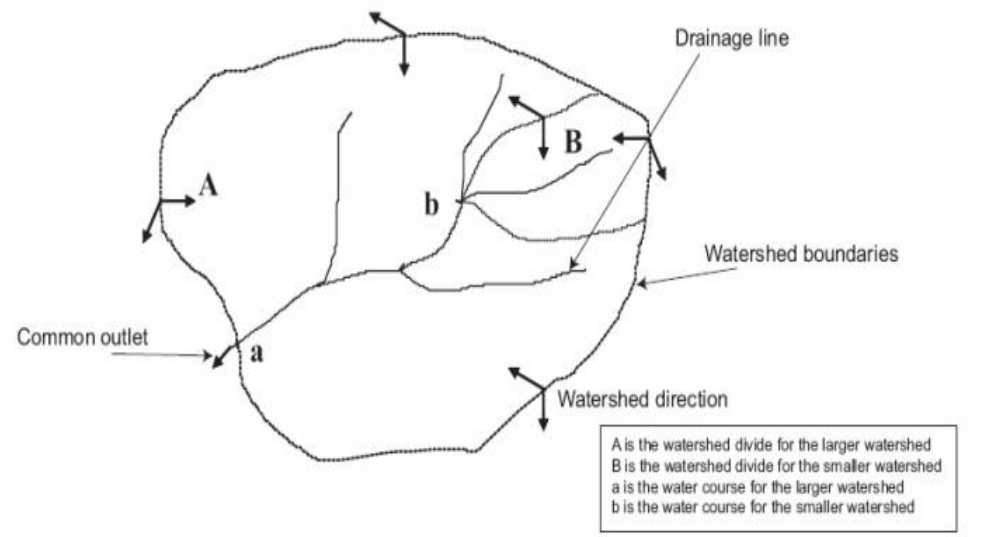
Introduction

Watershed is the drainage area on the land surface from which runoff or excess water from rainfall reach at a special point known as common outlet. It is the common point from which the excess amounts of water collected and distribute through outlet to the connecting sources. Or you can say that it is the common method to collect the runoff water. As we know that the agricultural system is totally depends upon the water sources, without proper source of irrigation water agriculture is not possible in any situation. watershed is a geographical area that drains to a common point, which makes it an attractive unit for technical efforts to conserve soil and maximize
utilization of surface and subsurface water for crop production (Kerr et al., 2000).

A watershed, also called a drainage basin or catchment area. People and livestock are the integral part of watershed and their activities affect the productive status of watersheds and vice versa. From the hydrological point of view, the different phases of hydrological cycle in a watershed are dependent on the various natural features and human activities. Watershed is not simply the hydrological unit but also socio-political-ecological entity which plays crucial role in determining food, social, and economical security and provides life support services to rural people (Wani et al. 2008).

The planning and designing of soil and water conservation structures likewise water harvesting structure overflow structure, bunds, water ways etc. Thus, it is essential to development of various programs related to watershed basis in conjunction with fundamentals of soil and water conservation practices. The watershed development program needs to be taken up from ridge line to outlet point. The main purpose of watershed management program in dryland areas is to optimum and collective use of agricultural lands, water, vegetation in a particular area for providing facility to reduce the drought impacts, moderate floods, reduce soil erosion, increasing availability of water and increase food, fuel, fodder and fiber on sustainability basis.

Watershed management is primarily synonymous with the soil and water conservation with the basic concept is to reduce the floods and sediment control besides increasing agricultural food production. The basic objective of watershed management is to meeting the problems of land and water use. Not in the sense of single resource but on the basis of all resources are independent and most valuable. The ultimate aims of watershed management is the improvement in the living standard of common person particularly farmers family. It is possible by increasing the earning capacity, by offering facilities likewise rural electrification, water supply for daily use, water for the purpose of irrigation, free from all the abnormalities like floods and drought.



The main objectives of watershed development programs are given below

- Recognitions of watershed on unit basis for improvement and proper use of lands by following the land capability classification
- Control of floods by constructing the reservoirs like multi-purpose reservoirs
- Water dams at head water of streams and in problem areas
- Adequate water supply for agriculture
- Proper source water for drinking purpose
- Supply sufficient amount of water for industrial needs
- Management of various agricultural pollutions
- Reducing the environmental pollution

- Abatement of organic and inorganic pollution
- Efficient use of all non-artificial resources
- Increasing agricultural and allied sector occupations
- Improve socio-economic conditions of the local farmers
- Development or recreation facilities like picnic and camping sites.

1.1. Selecting materials

Selecting appropriate materials for watershed management includes

- GIS
- GIS software
- Topo map
- Aerial photo
- Compass
- GPS
- Pencil
- A4 or A2 pepper

Self-check 1	Written test

Name…… ID…… Date……

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Give short answer (6 point)

1. Define watershed
2. List down the objectives of watershed development
3. Mention at least four materials used for watershed development

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Information Sheet 2- Delineating critical and micro/sub watersheds

2.1. Delineating critical and micro/sub watersheds

The Basins Watershed Delineation tools allow you define multiple hydrologically connected sub-watersheds within a given study area. This is useful in watershed characterization. The Watershed Delineation tools allow you to define and create a boundary around the entire land area contributing to flow in a stream.

There are two types of watershed delineation

1. Topographic Maps

2. Digital Elevation Models

1. Topographic Maps

A. Concept of Map

A map is a graphical representation, at an established scale, of a part of the earth's surface, showing important natural and manmade features in their correct positions relative to a coordinate reference system and to each other.

Topographic maps represent features on the earth's surface by means of symbols and labels; separate colors distinguish the main classes of map features. The amount of information shown on a topographic map depends on the map scale, the purpose of the map, and the cost of obtaining the information.

Topographic map- A topographic map, as distinguished from other kinds, portrays by some means the shape and elevation of the terrain. Geological Survey topographic maps usually represent elevations and land forms the shapes into which the earth's surface is sculptured by natural forces by contour lines. Other features are shown by a variety of conventional signs, symbols, lines, and patterns, which are printed in appropriate colors and identified by names, labels, and numbers.

B. Elements of map construction

I. Colors and classes of features- The information shown on the quadrangle map is divided into three general classes, each printed in a different color.

- Information about the shape of the land surface, hypsographic or topographic information is printed in ***brown***.
- Water features, hydrographic information is shown in **blue**.
- Cultural features, manmade objects are shown in **black**. The system of division is not precise. Some manmade features--for example, levees (earth works) and earth dams--are also topographic features and are printed in **brown**, not black.
- Besides the colors used for the three main classes of features, **green** is used to show woodland, timber, brush, and orchards and **red** is used to show public-land subdivisions (cultural features) and the classification of the more important roads.

II. Lines and symbols. Linear features are represented by lines of various weights and styles (solid, dashed, dotted, or some combinations). Structures, or individual features, are portrayed by a system of pictographs or symbols. The symbols originated as plan views of the objects they represent, and they retain something of this character although they are now formalized. The building symbol, for example, is a solid or open square. The railroad symbol is a line with evenly spaced cross ties. The dam and levee symbols look approximately like dams or levees as seen from the air.

III. Letters and numbers. Because lines and symbols cannot represent map information completely, they must be supplemented by the names of places and objects. Notes must be added to explain some features that cannot be depicted clearly by symbols alone.

In mapping topographic features, the information portrayed (showed) by contour lines must be supplemented by elevation figures. Letters and numbers are essential to map interpretation, but they tend to obscure another map information.

IV. Map scale. Map scale is the relationship of the size of the map to the size of the ground area it represents. The relationship may be expressed as a linear equivalent, such as 1-inch equals 1 mile--meaning that 1 inch measured on the map represents 1 mile on the ground--or it may be expressed in many other ways. The scale of Survey maps is given in the form of a ratio or fraction, without dimensions; the numerator is the distance on the map, and the denominator is the corresponding distance on the ground. For example, 1: 24,000 means that one unit of length on the map represents 24,000 similar units on the ground.

In general, Map features may be represented as points, lines, or polygons. They incorporate different colors and patterns to distinguish between feature types and to show each feature's importance. For example, a perennial stream is symbolized by a solid blue line while an intermittent stream is shown by a blue dashed and dotted line. A large reservoir is depicted by a polygon while a small reservoir may be shown by a point symbol if it is too small to show as a polygon.

1. Delignating watershed boundary Based on topo map.

Step 1. Use a topographic map(s) to locate the river, lake, stream, wetland, or other waterbodies of interest.

Step 2. Trace the watercourse from its source to its mouth, including the tributaries. This step determines the general beginning and ending boundaries.

Step 3. Examine the brown lines on the topographic map that are near the watercourse. These are referred to as contour lines. Contour lines connect all points of equal elevation above or below a known reference elevation.

- The dark brown contour lines (thick lines) will have a number associated with them, indicating the elevation.
- The light brown contour lines (thin lines) are usually mapped at 10 (or 20) foot intervals, and the dark brown (thick) lines are usually mapped at 50 (or 100) foot intervals. Be sure to check the map's legend for information on these intervals.

- To determine the final elevation of your location, simply add or subtract the appropriate contour interval for every light brown (thin) line, or the appropriate interval for every dark brown (thick) line.

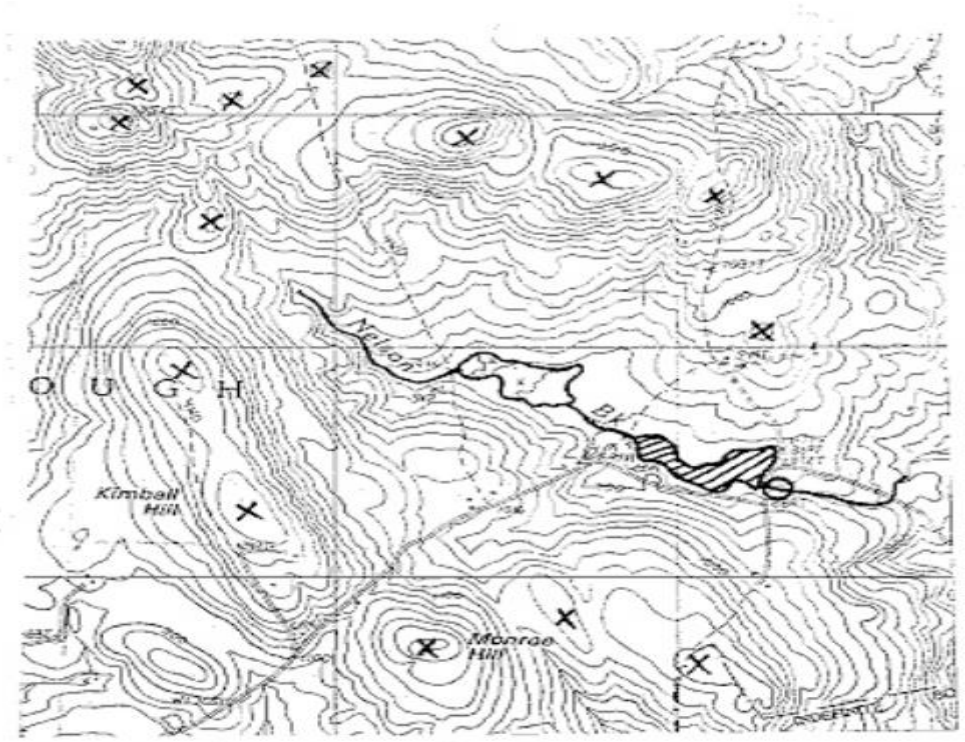
Step 4: see contour lines. contour lines spaced far apart indicate that the landscape is more level and gently sloping (i.e., they are flat areas). Contour lines spaced very close together indicate dramatic changes (rise or fall) in elevation over a short distance (i.e. they are steep areas)

Step 5. Check the slope of the landscape by locating two adjacent contour lines and determine their respective elevations. The slope is calculated as the change in elevation, along a straight line, divided by the distance between the endpoints of that line.

- ✓ A depressed area (valley, ravine, swale) is represented by a series of contour lines "pointing" towards the highest elevation
- ✓ A higher area (ridge, hill) is represented by a series of contour lines "pointing" towards the lowest elevation

Step 6. Determine the direction of drainage in the area of the waterbody by drawing arrows perpendicular to a series of contour lines that decrease in elevation. Stormwater runoff seeks the path of least resistance as it travels downslope. The "path" is the shortest distance between contours, hence a perpendicular route.

Mark the break points surrounding the waterbody. The "break points" are the highest elevations where half of the runoff would drain towards one body of water, and the other half would drain towards another body of water.

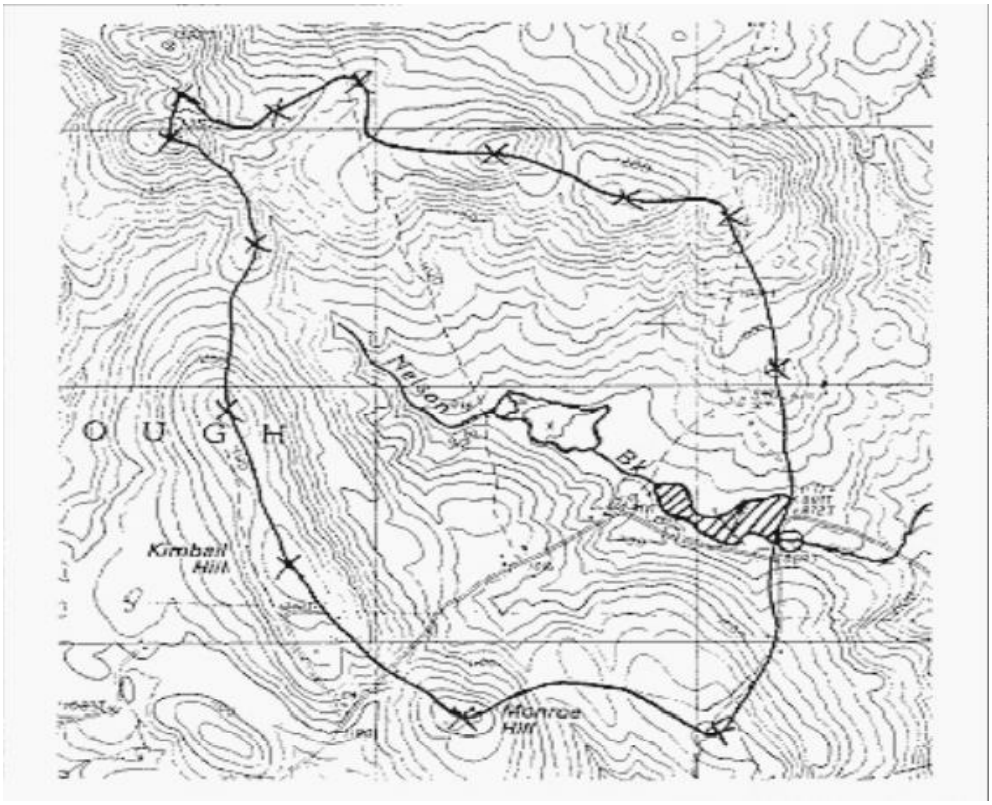


Step 7: Identify break points.

Connect the break points with a line following the highest elevations in the area.

This line should always cross the contours at right angles (i.e. it should be perpendicular to each contour line it crosses).

The completed line represents the boundary of the watershed.

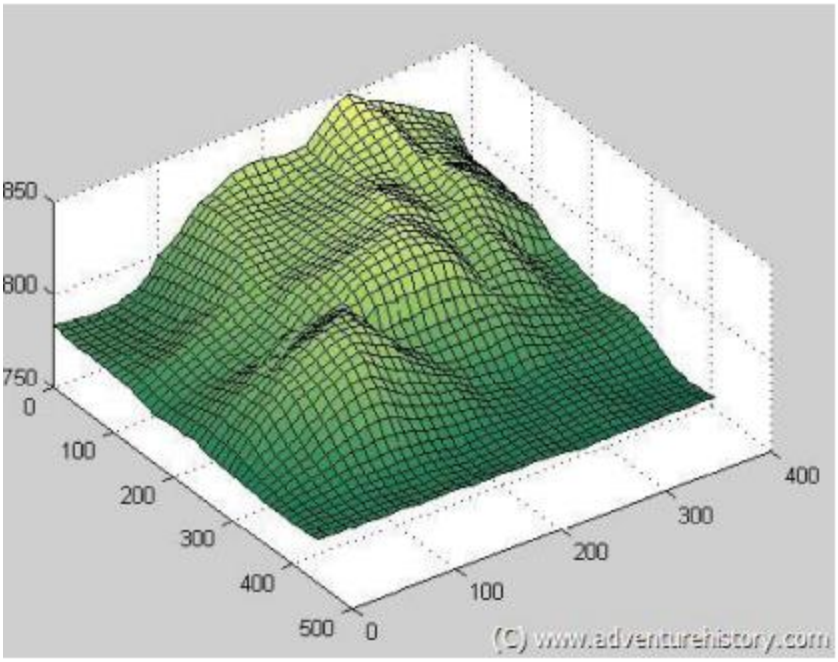


Step 8. Watersheds sometimes have what are termed sub-watersheds within them. Rivers, large streams, lake, and wetland watershed often have more than one sub-watershed (usually smaller tributary watersheds) within them. Generally, the larger the waterbody you are examining, the more sub-watersheds you will find. Your watershed map can be further divided into smaller sections or sub-watersheds if it helps organize your study better

2. Delignating watershed based on Digital Elevation Models

In this age of computers, geographic data can now be stored electronically. Digital Elevation Models (DEM's) store topographic data in the form of grid cells. Typically, these grid cells have a resolution of 30 meters and elevation intervals of 1 foot or 1 meter.

Using a DEM within a Geographical Information System (GIS), we can perform digital terrain analysis (DTA) such as calculating slopes, flow lengths, and delineate watershed boundaries and stream networks.



Delineation Steps There are two basic steps to follow in watershed delineation.

Step 1: Choose the point of the watershed outlet. This is generally our point of interest for designing a structure or monitoring location.

Step 2: Delineate the watershed boundary by drawing perpendicular lines across the elevation contour lines for land that drains to the point of interest.

Note - There are a few things to remember when you are working with topographic maps.

c) A watershed boundary always runs perpendicular to the contour lines.

d) “Arrows” that point upstream are valleys.

e) “Arrows” that point downstream are hills.

Self-check 2	Written test

Name_____ ID_____Date_____

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test II: Short Answer Questions

1. Explain what topo map is? (2pts)
2. List elements of topo map (5pts)
3. List the steps of watershed delineation by using topo map (5pts)

You can ask you teacher for the copy of the correct answers

Note: Satisfactory rating – 6 points Unsatisfactory - below6 points

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Operation Sheet 2 - Delineating critical and micro/sub watersheds

Objective to Delineate critical and micro/sub watersheds

Materials needed:

1. Topo map of the area
2. Pencil
3. Pepper
4. Eraser

Procedures:

1. Get topo map of your area
2. Sit on the right direction to read the map (N)
3. See the map correctly
4. Identify micro watershed on topo map
5. Delineate the area of micro watershed
6. Develop and map micro watershed
7. Collect the equipment's you used and store in appropriate place.
8. Prepare a report to supervisor

Information Sheet 3. Identifying and Describing Natural Processes

3.1. Identifying and Describing Natural Processes

Importantly, no matter where we live or work, we are in a watershed teeming with unique, interrelated natural processes. These natural forces help shape the watershed landscape, its water quality, and in turn our lives.

3.1.1. Hydrological cycle

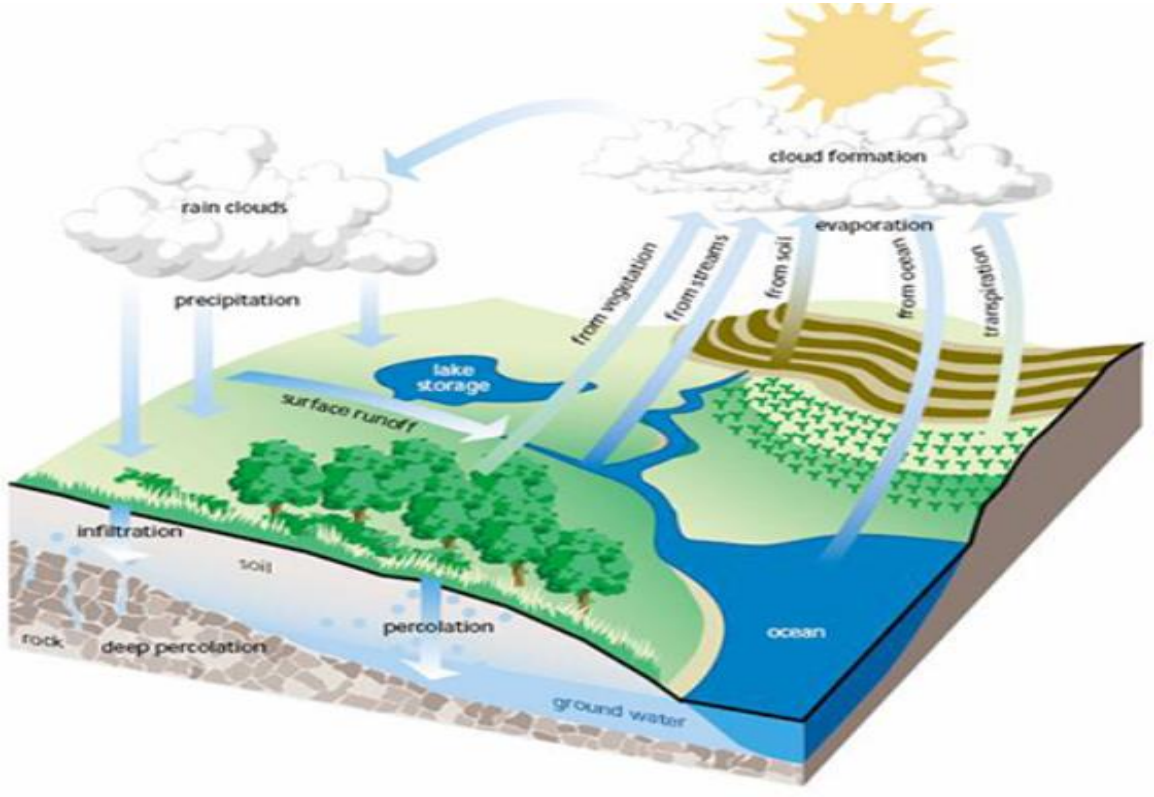
The hydrological cycle describes the movement of water within a ecosystem, for example a watershed. As this movement refers to the circulation of water between the individual reservoirs of the watershed it is termed local water cycle.

The cycle starts when

- water falls as precipitation (rain, snow, etc.)
- to some extent it is intercepted by the vegetation
- precipitation which reaches the land surface evaporates partially
- together with the amount of water which is transpired by the plants, part of the fallen precipitation returns to the atmosphere (this process is termed evapotranspiration)
- the other part of the precipitation may partially infiltrate into the soil (subsurface water)
- if the subsoil layer is saturated by water or if pipes exists, the infiltrated water runs as interflow downward inside the soil
- some amount of water percolates deeper into the bedrock and enters the groundwater reservoir. The top of this zone is termed the water table. Water which is stored as groundwater in pores and fissures runs with long delay as base flow to the receiving water;
- the precipitation that reaches the soil surface and was not absorbed by the soil may be stored temporary in puddles on the surface if the upper soil is impermeable or saturated with water.

The most basic and essential tool for understanding these interactions is the **hydrologic cycle**. As the term implies, the hydrologic cycle describes how water is stored and moves within and among watersheds.

The major components of the hydrologic cycle are precipitation, evaporation, transpiration, soil water, groundwater, and streamflow.



A. Precipitation - provides the input of water to watersheds, primarily as rain, snow, sleet, and hail. Fog and freezing fog also may provide a substantial amount of the annual precipitation input in some high-elevation ecosystems. Regions that receive the majority of their precipitation as rainfall are classified as rain-dominated systems, whereas those that receive primarily snowfall are classified as snow-dominated systems. In the United States, snow-dominated systems tend to be located in the West and at higher elevations. These climates may have rainfall, even commonly, during the growing season (e.g., short afternoon thunderstorms in some Rocky

Mountain areas), but in terms of the total annual contributions to **streamflow**, rainfall inputs are small.

B. Transpiration- is another way moisture is lost from a watershed. Transpiration is evaporation of water from leaf stomata (i.e., tiny leaf openings where gases are exchanged) following movement of ground moisture from the roots upward through the tree (i.e., translocation). Consequently, for transpiration to occur, moisture must be present in the upper layers of the soil where feeder roots are predominantly present. In forests, transpiration accounts for much greater losses of moisture than any other mechanism in the hydrologic cycle. A single mature tree can transpire tens to hundreds of liters of water per day, depending upon soil moisture availability. In a worldwide review of vegetative water use, trees with at least a 51-cm diameter transpired an average of 265 liters per day (Wullschleger et al. 1998). Because evaporation and transpiration depend on the same physical processes to transform water from a liquid to a gas and because they each result in losses of moisture from a watershed, the two are often considered together and termed evapotranspiration in the hydrologic cycle. Evaporation and transpiration rates vary widely depending upon many factors, including precipitation, temperature, aspect, humidity, and wind (Gregersen et al. 2007).

C. Stormflow is the component of streamflow that results directly from current precipitation or snowmelt events. Stormflow is delivered to surface waters primarily by subsurface flow through macrospores and mesopores that connect to stream or river channels. While these pathways can exist anywhere within the soil, in many (if not most) forested watersheds, the location of many of these pores is believed to be directly on top of bedrock or soil layers with low permeability. Thus, water is transmitted vertically downward to the impermeable layer and it then flows along the top of that layer until it is discharged into the water body. Some precipitation or throughfall may fall directly into a water body, and this is called direct channel precipitation or channel interception.

Self-Check –3	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions. (10 point)

1. List down the main components of natural process in watershed management (4pts)
2. What is hydrological cycle and why it is important in watershed development? (4pts)
3. If natural process cannot function properly, what happen to watershed development process? (2pts)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Information Sheet 4- Identifying and Describing Human Factors

4.1. Identifying and Describing Human Factors

The geographical boundary of a watershed is rarely if ever a boundary shared with spaces of social and political organization.

Social organization occurs around many different geographical boundaries from municipal to ecclesiastical, but not around water flow.

Watershed management thus requires the construction of a new basis for social connections. In other words, watershed management requires a collective vision and the adoption of coordinated natural resource use and management practices, developed around the geography of the watershed. Many projects have failed because there has not been a sense of a watershed as a site for both biophysical and social (inter)actions. Building this social sense requires some form of collective action (Ronnie Vernooy, personal communication, August 2004).

Working with your watershed also means understanding how most human activities in the watershed can occur in harmony with natural processes. Communities located along streams and rivers, for example, are faced with very basic choices: they can learn how the river functions and learn to draw benefits from it while staying out of harm's way or they can try to significantly change the river's behavior in order to accomplish their plans. It may be feasible to change the way a river acts, but this usually means taking on costly and never-ending maintenance of those man-made changes; and, despite all the maintenance, communities may remain still vulnerable to floods and other disasters. In contrast, a community that has made sensible decisions on activities near the river can avoid a costly maintenance burden while sustaining their community's use and enjoyment of a healthy river system. In which type of community would you rather live and pay taxes?

Why is it important to know about these human activities and where they occur in the watershed?

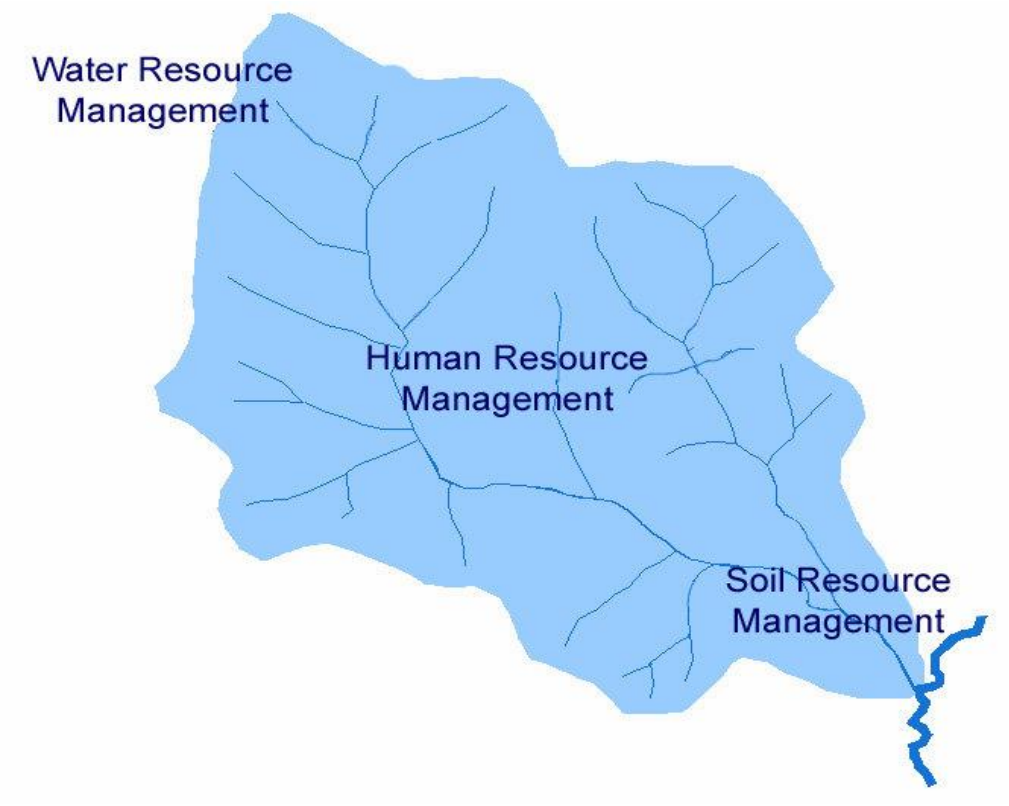
These human forces interact with the natural forces to directly shape the condition of the land and water. For example,

- increasing impervious surfaces in the urban areas leads to increased water and contaminant runoff
- removing vegetation along drainage areas and increased stormflows lead to erosion of soils which can change the landscape to more arid conditions
- increasing the velocity of the water and contaminants it contains can be lethal to living things or it can create health hazards, reducing our quality of life.

Once you've conducted a simple screening for potential stressors, you have a better sense of where to do more in-depth investigations, including getting out in the watershed to conduct stream walks, windshield surveys, and strategic water quality sampling.

So, watersheds are natural systems we can work with because

- They are practical, tangible management units that people understand, and
- They help us understand and appreciate nature's interrelated processes and how our actions can be tailored to complement rather than impact them.



Picture: relationship b/n watershed & human

Self-Check –4	Written test

Name…… ID……. Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions. (10 point)

1. What is the role of human factors in watershed management (3pts)
2. Explain the r/p b/n human and watershed. (3pts)
3. List the negative impacts of human in watershed? (4pts)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – 5 points** **Unsatisfactory - below 5 points**

Information Sheet 5- Size of the watershed, Population and Current land uses

5.1. Size of the watershed, Population and Current land uses

5.1.1. Size of the watershed

A watershed may be only a few hectares as drainage area for filling small ponds or hundreds of square kilometers for rivers. The size of the watershed should be based on the community or communities depending on the watershed. A suitable watershed size is required for effective planning for conservation and maximum production. Efficient management of watershed resources is possible through an appropriate unit so that the resources are managed and handled effectively, collectively and simultaneously. The maximum size of the watershed that should be taken as a planning unit is suggested to range from 200 to 500 ha. Lower size than 200 ha may occur and may be considered in few cases but usually these smaller units are to be included as sub-watersheds within community watersheds. Some exceptions on the upper side may occur, particularly in drier areas where villages are scattered under larger watershed units and natural resource development is possible only if larger units are considered.

Watersheds is classified depending upon the size, drainage, shape and land use pattern.

- Macro watershed (> 50,000 ha)
- Sub-watershed (10,000 to 50,000 ha)
- Milli-watershed (1000 to10000 ha)
- Micro watershed (100 to 1000 ha)
- Mini watershed (1-100 ha)

In this case, however, sub watershed units can be identified and prioritized for key interventions before others.

As the decision-making unit for any watershed is the community, the starting point for planning is the community and its surroundings. Within the above size range, a watershed will be then selected as much as possible to:

- ✓ Include the community or most parts of a community comprising the smallest unit available (*gott*, *genda*, and others). One *kebele* could have several watershed plans.
- ✓ Include more than one community where the interactions between two or more communities are closely linked to the watershed they share. The number of communities should be within one *kebele*.

Include only a portion of a community that is widely scattered having two or more main sub-watersheds cross the community. In this case, several sub-watershed plans can be developed and linked one to the other.

Based on the experience of various countries, a watershed size of 500 hectares creates homogeneity in most aspects. This facilitates greater planning and implementation. It is the maximum size recommended in this Guideline. When the size is large, it is difficult to organize the community to undertake the surveying, planning, implementing, and monitoring tasks at one go. Those watersheds with high and diverse development potential will tend to be smaller than those in the arid and pastoral areas having limited agricultural potential.

The size of a watershed to be chosen for land development/soil conservation also depends upon the objective(s) of the nature of the land development planning to be attempted. If the major objective is to conserve rainfall and replenish water-tables in dry areas, for example through moisture conservation-based activities (trench bunds, and others.), then the size of the watershed can be larger, between 500 and 1000 ha, a conventional size for planning soil and water conservation treatment. The same is true for protecting feeder roads crossing various villages under fragile hillsides and some other works. In this case, different village or community level watershed plans can be clustered (grouped) and form logical continuums and broader watershed units for those specific activities of common interest or mutually beneficial (like the raising of water-tables).

For integrated development of watershed for agricultural purposes, time and available resources are important criteria when deciding the size.

5.1.2. Land use and watershed.

Soil is considered a living and dynamic resource whose condition is vital as much for agricultural production as for the functioning of the ecosystem. “Given its role as regulator in bio-geochemical nutrient cycles, as a modulator of water availability and quality, as well as its role in filtration and decomposition of contaminants, soil is a key natural resource for our future survival.

Land use has drastic impacts on soil quality, and the quality of soil and water are principal indicators for impacts of land use on watershed health. The ties between land use and watershed health have become clearer over the past decade as linkages between soil and water indicators have been better understood. Changes in land use modify sediment transport, nutrient fluxes, stream courses, temperatures, animal populations, water balances and many other natural dynamics (Schreier et al. 2003). Agriculture, the principal productive activity in most of the watersheds of projects reviewed, can have significant effects on water quality. Heavy doses of fertilizer and intensive use of agricultural land have been demonstrated to have a strong negative impact. The main pollutants are microbes, phosphates and nitrates. Harmful fecal coliforms mainly come from human and animal waste. Phosphate and nitrate pollution mainly originate from agricultural practices (fertilizer), and eutrophication (drop in oxygen levels causes by increased algal growth due to excess nutrient enrichment of surface water) can now be observed in many lowland sections (Merz et al. 2003).

In urban areas, point-source pollution and untreated storm flow are the major concerns. In rural areas, such as the middle mountains of Nepal, water quality deterioration is rather the result of non-point-source pollution by human waste and intensive agriculture with high mineral fertilizer and pesticide inputs. In certain locations, increasing numbers of livestock for dairy farming are adding to the non-point-source pollution problem. The dry season of water scarcity increases the effects of the pollution on human and animal

health and, during the rainy season, feces and other pollutants are washed into the river system, also putting health at risk (Merz et al. 2003).

Population and land use characteristics are important indicators of current and future watershed health when assessed together. The way land is used directly affects how water moves throughout the entire watershed, influencing whether it supports water quality, quantity, and ecosystem functions or threatens them.

Land use has a major impact on the water quality of both surface and ground water. Land use refers to the human use of the land. Certain kinds of land use can change the hydrology of the Watershed, altering the way water and pollutants move through the drainage basin.

Land-use/land-cover (LULC) change is one of the main contributing factors, affecting discharge and water quality in watersheds, due to anthropogenic activities, for example, increasing population and urbanization, encroachment of forests by agriculture and urban areas, and the degradation of forest resources. This can result in a decrease in infiltration and, in turn, an increase in the rate and volume of surface runoff, as well as having a negative impact on water quality, which is a major concern in terms of drinkable water supplies (Chotpantarat and Chanyotha 2003, Fitzpatrick 2005, Klongvessa *et al*. 2017)

Self-Check –5	Written test

Name…… ID……. Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Short Answer Questions. (10 point)

1. How land use land cover change would affect the quality of watershed (3pts)
2. Mention the types of watershed based on their size (3pts)
3. What is land use land cover change? (4pts)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – 5 points** **Unsatisfactory - below 5 points**

LAP Test	Practical Demonstration

Name. _____ID _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 2 hours.

Task 1. Delineate micro/sub watersheds

LG #59	LO2: Consider the Principles of Long-term Watershed Management

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Coordinating multi-disciplinary activities
- Carrying out and analyzing data gathering for watershed planning
- Prioritizing and targeting major constraints and possible solutions
- Developing a workable watershed development
- Designing a strong watershed results framework condition
- Sorting out conditions for implementation, monitoring and evaluation

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, **you will be able to**:

- Coordinate multi-disciplinary activities over a management cycle to address continuous watershed management needs
- Carry out appropriate data gathering for watershed planning
- Prioritize and target major constraints and possible solutions
- Develop a workable watershed development plan based on assessment results
- Design strong watershed results framework conditions, facilitation for communication and partnerships
- Sort conditions for implementation, monitoring and evaluation

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets”
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1- Coordinating Multi-Disciplinary Activities

1.1. Introduction

Watershed Management is a holistic approach to managing water resources for quantity and quality within a watershed. Watershed management is also a useful, proactive approach in areas without immediate problems. The figure below demonstrates the Watershed Approach to Water Quality Management. By looking at watersheds, the state can evaluate all the sources of pollution that may be affecting the water quality and quantity.

Watershed management is a kind of organization and planning of activities (human) within the watershed boundary, and recognizing the relations between all concerned activates and the healthy features of watershed. Incomplete and improper management of watershed resources develop very dominating effect, leading to degradation of environment, low productivity, low income and lack of sustainability in the development.

The three main components in watershed management are land management, water management and biomass management. Land characteristics like terrain, slope, formation, depth, texture, moisture, infiltration rate and soil capability are the major determinants of land management activities in a watershed

The watershed is assumed as a “natural home” for managing the resource trinity-land, water and biomass in a sustainable manner. Watershed restoration is aimed to restore the already created effects (good) in watershed through proper monitoring. Watershed restoration program is also beneficial to redevelop/manage the resources.

Steps involved in watershed management

- **Site selection:** The site is selected in consultation with the concerned state and central development agencies and local bodies based on the following criteria prevailing soil and agro-climatic zones, nature of soil conservation problems and

land-use, socio-economic conditions of the region and its people, approachability and demonstration value.

- **Resource survey:** Components of the survey include physiography, climate, soil survey, engineering survey, land-use survey, vegetation survey, hydrologic survey, land capability survey and socio-economic survey.
- **People's participation:** It is essential to discuss the project with the people at the time of preparation and finalization of details of the ground plan.
- **Watershed development project plan:** Project plans should be prepared based on the basic data on resources potentials, needs and problems, the type and intensity of treatments, land-use plans and development of resources and infrastructures.
- **Treatment of watersheds:** Fuel, fodder and fiber plantations, orchards with suitable species and conservation measures will be useful in providing vegetative cover and economic produce apart from soil and water conservation for non-arable lands.

1.2. Multidisciplinary Watershed management

Multidisciplinary- Integrated watershed planning and management requires application of knowledge of various disciplines. The multidisciplinary planning team may include; land resource management and planning, agronomy, agro forestry, socio-economics, hydrology, geology, soil and water conservation, livestock development, irrigation etc.

It is therefore necessary that we need to coordinate our planning activities with the similar activities of other government and non-government agencies and obtain the necessary information required for planning.

Multidisciplinary approach is required to address the complex environmental problems of our time. Solutions to climate change problems are good examples of situations requiring complex syntheses of ideas from a vast set of disciplines including science, engineering, social science, and the humanities.

Multidisciplinary' involves parallel inputs from different disciplines without requiring consultation between them. 'Interdisciplinary' implies interaction between different

disciplines in relation to the watershed problem and throughout the management process, beginning ideally with the definition of the problem.

The multidisciplinary approach is most common, with projects tending to divide work along disciplinary lines with little real integration.

Dick Van Dusseldorf lays out the main components of interdisciplinary approach (van Dusseldorf 1992, cited by Kapila and Moher 1995):

(1) Studying the same object (2) at the same time (3) by members of different disciplines (4) in close cooperation and (5) with a continuous exchange of information, (6) resulting in integrated analysis of the object under study.

If the goal is integrated watershed analysis, then a team made up of a range of disciplines (for example: soil scientist, agronomist, and livestock specialist, and community facilitator) should work together on a common problem from the start of the project. The team physically works together, they see degraded land together, see fodder options together, observe livestock together, discuss production costs and profitability together, and most importantly discuss with farmers and community members all aspects of the area or topic. With the local people, they come up with solutions together, implement actions together, then monitor and evaluate the action together. This interdisciplinarity also requires clear qualitative and process indicators for concrete and identifiable goals that conceptually integrate the different disciplines and their methodologies. Systematically registering this allows interactions to be better identified and tracked. Integration of socio-economic and biophysical aspects of watershed management should also be part of a larger participatory planning process that includes strategies for sharing, applying and promoting the data and knowledge that accumulates.

Watershed Management is a continuous cyclic process.

1.3. Watershed Management Principles

The watershed management tasks are very sensitive to each and every involvement. The watershed management is assumed to be successful, when it is carried out under proper planning approach, objectives, implementation methods and attitude of associated staffs. However, it is also based on the concrete principle for better management.

There have been devised several principles to operate the watershed management tasks, effectively; few important amongst them are outlined as below:

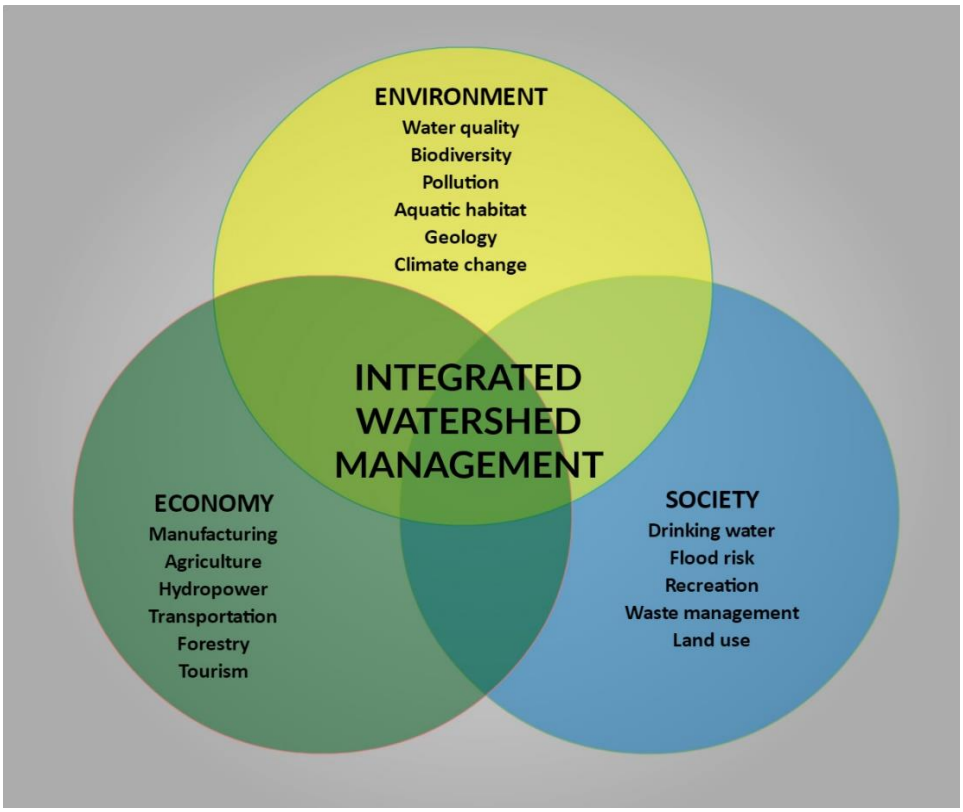
- Watershed should be in natural form.
- The watershed management should be on multi-disciplinary approach.
- A strong framework should support the watershed management, in proper way.
- There should be proper team of personnel and with most appropriate technology, as well.
- The approach should be flexible.

The important watershed management principles based on the resource conservation, resource generation and resource utilization are given as under:

- ✓ The utilization of land resource should be based on its capability.
- ✓ Protection of top fertile soil depth should be there.
- ✓ The silting of farm pond/tanks, reservoirs and foot hill fertile lands should be checked.
- ✓ There should be the provision for protecting the vegetative cover throughout the year, to maintain the soil in proper form.
- ✓ In watershed there should be priority for in-situ rainwater conservation.
- ✓ In gullied areas there should be safe diversion of runoff and construction of check dams for reclaiming the gullies, and also enhancing the ground water recharge.
- ✓ The cropping intensity should be high, which can be done by adopting inter-and sequential cropping systems.
- ✓ For efficient use of marginal lands, there should be alternative land use systems.
- ✓ For development of supplemental irrigation facility in the watershed, there should be the provision of rainwater harvesting.
- ✓ In order to maximize the farm income, there should be the introduction of agriculturally based activities, such as dairy, poultry, sheep and goat farming in the watershed.
- ✓ There should be very good infrastructures related to storage of farm produce, transportation system and agricultural marketing.
- ✓ The overall objective of watershed management should be oriented to improve the socio-economic condition of the people living in the watershed.

The watershed management implies the judicious use of all the resources, i.e., the land, vegetations and water in the watershed to achieve maximum production with minimum hazard of the natural resources and for the well-being of people. The management should be carried out on the watershed basis. The natural resources within the **watershed** has to be stabilized, protected and kept free from pollution.

The productivity of resource utilization has to be increased in an environmentally, economically and also institutionally sustainable manner.



Picture. Integrated watershed management

Factors affecting watershed management

a) Watershed characters

- Size and shape
- Topography
- Soil
- Relief

b) Climatic characteristic

- Precipitation- Amount and intensity of rainfall

c) Watershed operation

d) Land use pattern

- Vegetative cover
- Density

e**)** Social status of inability

f) Water resource and their capabilities

Self-Check –1	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part I. Give short answer (12pts)

1. List at least four main factors that affect quality of watershed management (4pts)
2. List the three main components of watershed management (2pts)
3. What is watershed management? (2pts)
4. List down at least four principles of watershed management (4pts)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 6 points** **Unsatisfactory - below 6 points**

Information Sheet 2- Data Gathering for Watershed Planning

2.1. Data Gathering for Watershed Planning

Data collection- It accomplishes under the following heads

A. Watershed description

- Location - the information such as name of river basin, tributary, physiographic region, and principal communication lines associated attitude and longitude of watershed are collected.
- Size and shape - the size of water shade either km^2 or and shape of watershed is long and narrow, or fan shape whatever those are should be mentioned.
- Climate - the following details are usually collected
    - ✓ Precipitation
    - ✓ Temperature
    - ✓ Evaporation
    - ✓ Relative humidity
- Geology - it includes the geological information such as nature of parent rock, fractures, faults, weathering ground water recharge and extent of out crops.
    - ✓ Surface drainage
    - ✓ Nature of stream flow
    - ✓ Drainage net work
- Physiographic: - it consists nothing the details of evaluation of different parts of watershed mountainous range etc.
- Watershed need:- under this the contents such as source of surface and subsurface water, water use for domestic, irrigation ,power generation and recreation, future needs of water exploration ,etc. are recorded
- Land use and cover condition such as
    - ✓ Existing land use and cover conditions
    - ✓ Forests

- ✓ Range lands
- ✓ Agricultural lands
- ✓ West lands
- ✓ Habitation lands

- Economic data: - the economic and social data are needed to be determined. Under this the following data are collected.

B. Watershed problem - the entire problem such as flood, drought, erosion, sediment damage and other problems related to conservation, utilization, and disposal of water in the watershed should be identified.

C. Proposed management programs: - All the management activities (physical and Agronomic/ biological management) should be included.

The kinds and amounts of data that are necessary for planning watershed improvement projects will depend in part upon the nature and purposes of the project. Where the scheme being planned is primarily a demonstration activity it may be necessary to collect somewhat more detailed information on the initial situation than would be required for a general project of watershed improvement.

1. Meteorological information
2. Hydrologic information
3. Soils and land use data
4. Economic and social information.

1. Meteorological information

Emphasis should be placed on the collection of data on precipitation. This should include measurements of annual precipitation, its seasonal distribution, and the characteristic of typical storms such as duration, intensity of rainfall and the frequency of storms delivering various amounts of water. Information on temperature conditions is particularly useful where storm rainfall or runoff is associated with freezing temperatures.

2. Hydrologic information

Enough information on stream flow conditions must be collected so as to be able to construct hydrographs for storms of the size for which protection is to be planned. As a minimum there should be observations or estimates of rates of flow under a wide variety of storm conditions and for periods following storms. In addition, it is important that estimates be developed of the sediment load of the stream in question. Adequate information must be acquired to permit careful designing of structures particularly to provide adequate flood storage capacity for the " design storm ", to provide sufficient spillway capacity to assure the safety of each structure and to provide adequate silt storage so that each structure has an economically useful length of life.

3. Soils and land use data

A detailed soil survey is an essential for adequate planning of a small watershed project. The information which such a survey will provide will not only serve as a basis for assessing the present situation, but is basic for planning land improvement activities such as afforestation, grass regeneration, terracing and other means for controlling surface runoff and soil losses. A detailed soil survey provides most of the information for a determination of the erosion situation and the delineation of major silt producing areas. The information on soil types is essential in choosing species of grass or trees for planting on particular sites and such information is also useful in forecasting the possible changes in infiltration rates as a result of changes in vegetative cover conditions.

4. Economic and social information

For purposes of watershed project planning a certain amount of economic and social data is essential. Some knowledge of the social structure of the area is important as a basis for planning means for enlisting full local co-operation in the work. In areas where settlement is organized on a village basis no special enquiry may be necessary to define the primary social groupings or to gain understanding of the leadership structure in the communities. On the other hand, in areas of open settlement some effort at community delineation and leadership identification may be necessary.

Sources of data could be Primary, secondary or tertiary

Self-Check –2	Written test

Name…… ID……. Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: Give short answer. (8 point)

1. List down data needed during watershed management (4pts)
2. What is the main metrological information obtained from metrological agency? (2pts)
3. What is data? (2pts)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 4 points** **Unsatisfactory - below 4 points**

Information Sheet 3- Prioritizing Major Constraints and Possible Solutions

3.1. Prioritizing major constraints and possible solutions

1. Poor Linkage and Information Sharing Between Concerned Institutions

The work of watershed management requires multidisciplinary professionals and stockholders who should participate from planning stage to monitoring and evaluation stage. So that, different actors in the watershed should be linked and work together for the common goal of sustainable benefits of livelihood and conservation of the nature. However, in most part of the country poor linkage between concerned institutions in the conservation work that completely lead the activity to perform poor and unsuccessful in parts of Ethiopia. Many called information is power. Having information or data about the new technology will reduce common errors to be done and time to achieve solution in the watershed management. In general, having the information about the given issues will benefit the acts and activities to be successful in short time.

Poor communication could be a cause for lack of information sharing among acts. Poor information sharing is not only from local actors, but also there is gap among policy makers and researchers in the higher level.

Currently, after fifty years of tedious huge measures of watershed management in Ethiopia, it is hard to find the comprehensive data about the measures of watershed management from the beginning in Ethiopia.

2. Lack of Community Awareness

Awareness is consciousness of person or people about a given activity or conditions. It is very important characteristics of human that affect the success of the watershed management measures. At some level quit number of people were not well recognized the presence of land degradation in their watershed. This means that, there is lack of awareness about land degradation and watershed management benefits among the

community. Lack of awareness could hinder the success of the watershed management to come in the community

3. Policy and Strategy Application Limitations

Policy is set of guidelines and directives to the state for harnessing resources and to provide the sectoral (agriculture, industrial and domestic) need in equitable way that leads to sustainable development. Policy is a guiding principle of major goals and activities to specific measures prepared by the governing bodies. Various natural resources and watershed related policies and strategies were prepared by the government in different periods. However, there is still lack of properly implementation of the policy and strategies according to it were instructed on the document at site or lower level of administrations. If it is not executed as it was recommended, it will not have value or not bring any positive change on the natural resources.

In other hand, some policies and strategies could limit appropriate execution and sustainability of soil and water conservation measures at watershed level. Other policies could have limitation in different aspects so that it may need continues improvement of policy and strategy documents specially to tackle the limitations observed in the policy documents.

Apart with these strategy and policy constraints, the policies and strategies were prepared by categorizing the country according to their potential as low and high yield production.

The implementation of watershed management measures was targeted by the policies and strategies to low production potential areas where deficiency of food production usually existed. Following this, many development and relief organization have targeted low yield production potentials to intervene degradation problems and most activities have been implemented and concentrated in the few areas

4. Socio Economic and Bio Physical Constraints

Socio economic conditions could affect the success of watershed management measures positively or negatively. Similarly, the bio physical condition such as climate, topography, soil and drainage system could impact the achievement of watershed management measures in rural areas. It is expected that the constraints of socio economic and bio physical conditions could lead to the failure of the watershed measures in various location. There is many socio economic and bio physical constraints that hinder the development of watershed management practices in the watershed.

Among the major socio-economic constraint, poverty is one and crucial condition that need consideration and tackling mechanisms prior to or while implementation of watershed management measures. Poverty is the fundamental socio-economic problem affecting not only the sector but also most of the Ethiopian population. There is a strong connection between worsening poverty and land degradation in the rural areas. This constraint is not only a chronic problem made worse by a range of shocks, but also causes enormous environmental loss as the poor are pushed to mine the rapidly deteriorating natural resources. The indication of various impacts of poverty on land management is mixed and depends on the type of land management and the nature of poverty considered.

The constraints on social and economic status such as gender, youth, age, social position, education level, population growth and ownership and other conditions could also affect the effectiveness of watershed management activities. Rapid population growth is also one of the major socio-economic constraints the highland of Ethiopia is confronting as it could contribute for land degradation and worsening of poverty in Ethiopia. As the population growth rapidly the need for food, energy, water and other land resources could also grow simultaneously. Among the biophysical constraints that may affect successful implementation of watershed management, climate variability is becoming a significant factor, especially for the lowland sections of the country. Increasingly, erratic rainfall has been reported to be a hazard in main part of the country. Climatic variability is seen in recurrent droughts and this is associated with high rainfall variability, which have long been a feature in Ethiopia, and contributed to the decline in

vegetation cover, loss of biodiversity and ultimately worsening land degradation.

5. Technical Capacity Constraints

Practical watershed management measures require knowing and understanding technical methodologies and skills prior to implementation of the conservation measures in the watershed.

Even more, prescribing solution for any conservation related problem at different part of watershed also require an in-depth knowledge and experience on specific issues of watershed management. Most of applications in the watershed management are requiring knowledge of hydrology, engineering, forestry, agronomy, sociology, economics, extension and/or other background course.

This means that the management of watershed will require an interdisciplinary knowledge or working with inter disciplinary group of people. Some extension experts at local level may lack the capacity mentioned above at some level. In other way professional biasness could impact their decision on watershed management as most expert assigned to do the activities without having background knowledge of managing watershed issues in a community. For instance, the assigned agronomist could dominate activities of crops management in the entire watershed, while other resource conservation expecting the compromising decision on water, forest, soil and wild lives conservation. There could be capacity difference between local experts in productive and less productive areas. Lack of technical expertise could be caused by poor trainings, experienced expert turnover, lack of on job training from senior experts and lack of guidelines for local level experts and extensions assigned on watershed management activities.

6. Financial and Incentive Constraints

For every watershed management measure to be successful and bring changes in each watershed, finance is very crucial. Every activity could require allocated money or budget to be expended for watershed conservation.

Different findings have confirmed that provision of incentive for participants in watershed management activities could help the measures bring positive changes in the landscape and livelihood aspects.

In most part of the country watershed conservation activities especially soil and water conservation, tree planting and area closure measures were done by community mobilization without payment to the farmers for 45 days [60]. Apart from the community mobilization activities other watershed management measures must get financial support.

The constraints of financial and incentives support could impact the successfulness of the watershed activities. As most activities requires human work force, some financial support or wage should be given for the worker. When there is lack of finance, the work will not be done or stop at the middle. As a result, the goal of that specific watershed management measures could not be achieved as a result of financial deficiency.

Possible solution

1. Collaboration is a successful way to address a complex set of issues.
2. Collaborations can turn apparently inflexible federal or state mandates into opportunities
3. promoting innovation and integration of state agency programs.
4. integrating economic, environmental, and community objectives.
5. provide an alternative form of governance for conflicts that don't lend themselves to traditional governmental approaches.
6. Classifying Watershed Condition
7. Prioritizing Watersheds for Restoration
8. Developing Watershed Restoration Action Plans
9. Management program for agricultural lands- to control deterioration of agricultural lands the various control measures for them are divided in to the following two groups:

a. Agronomic measures

- Crop proposed
- Crop rotation
- Cultural operations
- Introduction of improved seeds
- Use of manure and fertilizer
- Plant protection me assures
- Expected yield obtained
- Expected cost invested

a. Engineering measures

- Proposed measures and their justifications
- Specification of individual measures with plan and design
- Cost estimation

10. Management programs for conservation irrigation

Self-Check –3	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: short answer. (10 point)

a. List down at least four problems of watershed management(4pts)

b. What is the possible solution for the mentioned problems in Q#1? (4pts)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 4 points** **Unsatisfactory - below 4 points**

Information Sheet 4- Watershed Development Plan

4.1. Watershed Development Plan

Watershed development Planning is a process for deciding what to do and how to do it. It is particularly important in connection with watershed improvement. The problems of a watershed area are usually so tangled and so complex it is hard to know where to begin. Moreover, it is often the case that the solution of problems that seem obvious on first study may turn out to depend upon the solution of more fundamental problems when more careful investigations are made. It is not uncommon, for example, for a catchment area to present a need for terracing as a means of controlling surface flows of water, but for the terracing to be impossible until some means is found for rationalizing a highly fragmented pattern of land ownership. Similarly, there are areas where the need for afforestation is obvious but where it is not possible for afforestation to succeed until some changes are made in customary grazing rights on the land.

It is also usually the case that one aspect of the development of a catchment area will depend on what is to be done elsewhere. The silt storage capacity to be designed into reservoirs will depend in part on the action to be taken to control erosion on the lands of the catchment area. Plans for the control of grazing are usually dependent upon the development of some alternative source of forage for the grazing animals. All of these aspects of watershed improvement are related and careful planning is necessary if the work is to lead to a successful result.

While watershed improvement work can produce spectacular results, it requires both money and time and, if these are not to be wasted, careful attention must be given to the planning of each project. It is tragic when 10- or 15-years' time is wasted because efforts have been made to produce a forest cover on lands not suited to the purpose; it is equally wasteful of resources when engineering structures are built, only to silt up quickly because not enough attention was given to erosion control work above them. It is doubly wasteful when time and money is put into land improvement works which are

allowed to fall into decay because no plans were made for their maintenance. The costs of careful planning of watershed improvement programs is small in comparison with the great investments that must often be made from both public and private sources. Particularly in countries where investment capital is in very short supply it should not be wasted as a result of a lack of careful planning of projects.

Plans for watershed management have two purposes. They are first of all a means for obtaining approval for funds to be spent and work to be done. There is never enough money nor enough time for all of the work of improvement and choices must be made as between projects. These choices are best made through a comparison of the plans for the alternate projects. It is difficult to decide whether investments should be made in the improvement of one catchment or another without knowing what each project is likely to cost and what the results are going to be. This knowledge comes out of project plans and the better the planning which is done, the more reliable will be the information on costs and results. Moreover, the better the project planning, the more confident will administrators be that the expenditures proposed will actually give the forecasted results. In most governments the process of approval for a project of work such as watershed improvement tends to be long and to involve the decisions of numerous people. A carefully prepared report on the project plan is a convenient device for simplifying and speeding the process of administrative approval.

A second purpose for a watershed project plan is to guide the work to be done. This is particularly important because most watersheds require a variety of kinds of action to be taken by many people, both private persons and officials of the government. Moreover, it is often the case that responsibility for the work to be done by the government is divided among several bureaus or organizations. For example, there may be work for the Extension Service in advising farmers on cropping systems for arable land that will minimize soil erosion, the Forest Service may have afforestation work and fire protection facilities to build, an engineering service may be involved in the construction of dams. An agreed-on plan for the whole program of watershed improvement makes possible the necessary co-ordination among bureaus. It also serves as a means for making clear what can be done by the Government and what must be done by the private land users.

A carefully prepared plan will also indicate the timetable for development, showing for example that certain land treatment measures for controlling erosion are to be installed before particular flood retarding reservoirs are built, thus precluding the possibility that the reservoirs may be quickly filled with soil materials washed from the uplands by destructive surface flows. The plan can also indicate the timing for developments that affect farmers' incomes so that to the extent possible the measures taken first will produce increases in income, thus making it easier for individuals to finance later parts of the necessary work.

The primary purpose of a watershed management plan is to guide watershed coordinators, resource managers, policy makers, and community organizations to restore and protect the resources water, biomass, soil, energy and human in a given watershed.

4.1.1. Organization for watershed planning

A bureau or department responsible for watershed improvement needs a subordinate organization for watershed planning. The nature of such an organization will, of course, depend upon many things. It will depend, for example, upon the scope of the watershed work to be undertaken. Also, it will depend upon the nature of the program responsibilities of the government bureau. A watershed improvement program of a Forest Service with responsibility in public forest areas will be different from that of an organization to deal with the mixture of problems found in catchment areas where all kinds of land uses and private as well as public lands are found. Similarly, the planning needs and the organizations for project planning will be different.

There are, however, some general principles which are useful guides for the organization of watershed improvement planning groups, regardless of either the size of the project, or the nature of the technical problems involved. In the first place the planning organization needs to be an integral part of the organization responsible for taking the action. The planning group, if it is organizationally separate from anybody responsible for actually making the planned improvements will find its plans being ignored rather than being acted upon, and the action organization on the other hand will

probably find it difficult to make use of the plans made by the independent planning group because of the apparent lack of attention to the practical problems of getting the work done. Planning and action must go hand in hand. There should be, of course, some degree of specialization. Not every member of the staff should be involved both in project planning and in project operations. The most satisfactory solution is usually found in having a relatively small planning team located in the operating organization where there is an easy communication between the planners and the project operations staff.

A second principle for guiding the structuring of a watershed planning organization is that the planning staff should include experts whose fields of interests cover all the aspects of watershed improvement that are involved in the areas under study. For example, a planning team for watershed improvement in the public forest may need to include only a hydrologist, forester and forest engineer. On the other hand, a planning body required to deal with problems of arable and grazing lands as well as the forest, and with private land ownership as well as public lands, will need the skills of other kinds of experts. Such a planning body should have technical competence in grassland management, and in agronomy and in addition should have experts with training and experience in the economics of farm organization and in land tenure, and in other institutional arrangements under which rural people live and produce their incomes. It will most usually be found that the most satisfactory planning organization personnel are those who have had some practical field experience in action-type programs and have supplemented this with special training in their technical fields. Both practical experience and advanced training are important.

4.2. **Types of watershed plans**

It should not be necessary to go into any detailed discussion of engineering design as related to watershed improvement. The detailed design of structures for retaining water, for controlling erosion and for related purposes is adequately covered in many standard engineering texts. It is important, however, to note that equally detailed attention is justified to non-engineering aspects of watershed improvement projects. The careful

detailed planning (design) of a program of afforestation for a particular watershed, or of an educational campaign to get land users to adopt erosion-retarding methods of crop cultivation is essential. Money and time are usually the most scarce resources in watershed improvement and these can be economized through carefully made designs, or work plans for each aspect of the improvement program. In engineering work a great deal of the time of highly skilled persons is devoted to careful planning of what is to be done. The same policy should be adopted for other features of watershed improvement work.

It is not easy to draw a line between planning and design, but some differentiation is useful. In the main, planning relates to the making of a decision as to what should be done, and designing is related to deciding how to do it. In engineering terms, design is usually understood to relate to the detailed planning of structures as a guide for those who will construct them. The same could be extended to other aspects of a watershed improvement program, with the term " design " used to mean the planning of detailed features of the operating program. However, it is more common to use the term " work plan " in connection with aspects of water shed work other than structural designs. This term will be used in this way in the report. There are many kinds of watershed plans, each having a special purpose.

B. River basin planning

Watershed improvement and management is one of the important aspects of comprehensive river basin planning. Together with plans for the construction of main-river facilities for generation of electric power, storage of irrigation and flood waters, or to improve navigation, attention is needed on the plans for work needed on the watershed itself. In many parts of the world, to ignore the watershed is to invite disaster. Particularly in those areas where the soils are highly erosive, failure to plan for the control of erosion may result in the siltation of costly reservoirs long before the end of their planned economic life. It is unfortunately true that watershed planning is most often neglected in comprehensive river basin planning, or at most receives all too little attention. This is sometimes the case because the river channel structures are looked

on as having a direct effect upon some major economic problem. They either provide an economic good such as electric power, or transportation, or irrigation water, or they minimize an economic loss such as flood damages. Watershed improvement, on the other hand, is often seen as being related only to the protection of the reservoirs themselves. In some cases it is possible to design into the reservoirs sufficient capacity for the storage of soil materials as to assure their useful life for a long period.

It is most often overlooked that the very work which is usually most necessary on the watershed for the protection of reservoirs is also of a nature which has a direct economic contribution to make. Practical soil conservation work is most often a form of improved land management which results in improving the productivity and usually the income from the land. In forests, in grazed areas and on arable lands this is found to be the case. The great possibilities for controlling erosion, and thus providing protection for reservoirs, is through getting private land users to adopt land management techniques which increase their incomes and, while doing so, preserve the soil resources in place, thus both sustaining the production of income and preserving the life of reservoirs. There are, of course, great areas in the world where the control of soil erosion is beyond the means of individual private land users, in these areas, to the extent they are in river basins where storage reservoirs are being planned and require that the designers of the dams and reservoirs include in their plans and cost estimates the necessary land treatment measures that must be undertaken at public expense.

The watershed improvement section of a river basin plan should also outline the various programs needed to get the necessary degree of land use improvement. It should cover afforestation, the management of grazing, and the use of arable lands. It should discuss necessary reforms in land tenure, desirable changes in legislation or government policy, adjustments needed in the organization of the Government's work, and should suggest lines for strengthening educational work among land users and other facilities of the Government such as agricultural credit and subsidy programs for aiding in improving the use of watershed lands.

C. Watershed area work plans

Watershed area work plan can be defined as one covering a catchment area which is to be the scene of a program of work. There is no useful measure of the size of such a watershed area. It can only be usefully defined as the area covered by a project work plan. In some cases where a very large project is envisaged the area may be several thousand hectares, in other cases it may be a watershed of very few hectares, perhaps only a half dozen farms. In any event, the significant feature of the area is that it is the subject of comprehensive planning, with the aim of indicating all of the various things to be done to achieve an improvement in the behavior of the stream that drains the area.

D. Community development plans

Watershed improvement work is usually difficult because people live in the watershed area. It is not very difficult to plan and take action on the problems of a forested watershed where the land is all owned and controlled by the state and private persons neither live there nor have any rights to the use of the land. On the other hand, when private persons have rights to the use of watershed lands, their private interests as well as the public interest must always be taken into account. A most effective way of dealing with such problems is through community development schemes. Here the primary social groupings of people, the village or neighborhood, is used as the basis for some system of social or political organization. The objective of such work is to promote self-help on problems of land and water use and on other problems related to these. It is not often that the boundaries of a watershed coincide with that of a rural community grouping of people and thus the area for watershed planning and the area for community development planning are most often different. It is usually the case, however, that watershed areas selected for improvement projects cover the area of several rural communities, villages, or neighborhoods and thus there is often a possibility of encouraging the development of community improvement plans as a means for promoting land use and related improvements in a part of a catchment project area.

The planning of community development is primarily a means for organizing the action of private persons to make their contributions to the improvement of their community and the larger watershed area. The plan itself most often emphasizes action on local problems, both community problems and individual farm problems.

Such community improvement work carried on as part of a watershed development project would of course place relatively heavy stress upon land use changes with desirable hydrologic consequences. These would include afforestation of privately-owned woodlands, control of grazing and fire in private or village forests, terracing and related water disposal systems, gully stabilization and other types of erosion control, improvement of vegetative cover on pastures, and other changes in land use that would have the effect of reducing soil losses and surface runoff.

E. Farm plans

On privately held arable lands, and to some extent on grazing and forested lands as well, the basic element in the structure of planning for watershed improvement is the farm plan. Every land user has some sort of plan. Most often it is not written down, and usually it is not even thought of as being a " plan " or as being related to the operations of a whole farm. Most often it is only a collection of habits and customs which result in a pattern of decisions made by the farmer. Haphazard as it may be, however, this pattern of decision making determines how the land will be used. The problem of the watershed improvement technician is thus to develop some means for influencing this farm planning. It is essential that watershed improvement work be built up from improvements in individual farm plans. The hydrologic behavior of a great watershed is in large part the result of the day-to-day actions of the hundreds or thousands of men who use the watershed's land for growing crops, grazing of animals, or production of wood. Changes in watershed conditions most often means changes in the operations of individual farms and this means changing the operating plans of these farmers.

These changes must be planned against the background of the economic and social objectives of the farmers. It is futile to suggest that a farmer adopt some soil and water conserving practice that will result in a lower income for his family. Similarly, realistic

plans for watershed improvement must take account of the social standards and preferences of people. Values attached by people to land and water resources strongly influence the care given these resources. Similarly, values attached to animals often influence the extent of grazing.

The farm plans that are required for watershed improvement must be " whole-farm " plans. They must be related to land use and also to many other aspects of the operations of farms and the lives of farm families. Improvement of grazing land through reducing the number of grazing animals involves planning also for means at least to maintain the production of meat, milk, fiber or animal power. This may mean developing alternate sources of animal feed, or improving the quality of the grazing animals and these, if they are to be accomplished, must be planned in a workable manner. Similarly, a plan to improve the vegetative growth on grasslands by fertilizer use, and thus control surface runoff and erosion, raises the problem of some means for covering the grass into income to pay for the fertilizers required. Here again, planning of animal production enterprises becomes important. In any planning of changes in land use on farms, the proposed change must be thought through to the end of its effect upon the operation of the whole farm. This process of " thinking through " is what is meant by whole-farm planning.

F. Problem spot plans

These are really parts of the work plans for watershed programs. They relate to the more critical areas in a watershed from the point of view of runoff and erosion and for the most part they cover the actions to be taken by the public agency concerned with watershed improvement. These may be extremely badly gullied areas where the necessary land use improvement is beyond the means either of individual land users, or of private persons co-operating in a village improvement scheme. The plans for such areas are usually concerned with engineering devices for soil stabilization plus such improvements in vegetative cover as afforestation or grass seeding. The plans for these areas often do not provide for any use of the area for a period of some years as their hydrologic improvement is so -important from the point of view of the entire catchment

area that their rapid healing is more necessary than their use for such purposes as grazing, crop production, or wood production.

A most important aspect of problem spot planning is economic analysis. The remedial work on such areas is always expensive and great care must be taken to minimize the costs of the work. Where there is unemployed labor, work in such areas can often be planned as a contribution to the public welfare through providing employment. Still it is usually the case that great care must be taken not to " overinvest " in the improvement of these critical spots. In some cases, time can be substituted for costly structures, and provisions for eliminating the cause of the difficulty, as for example, excessive numbers of grazing animals may in time give the desired results

4.3. Watershed Restoration Plans

Watershed Restoration Plan would include the following categories:

1. Executive Summary

a. Watershed Name

b. General Location

c. Watershed Area

d. Land Use

e. Key Problems

2. Watershed Characteristics and Conditions

a. General Context/Overview

(1). Climate

(2). Hydrology

(3). Geomorphology

(4). Other Resources

b. Watershed Conditions

(1). Uplands/Hillslope Conditions

(2). Riparian Conditions

(3). In channel Habitat Conditions

3.Restoration Goals, Objectives, and Opportunities

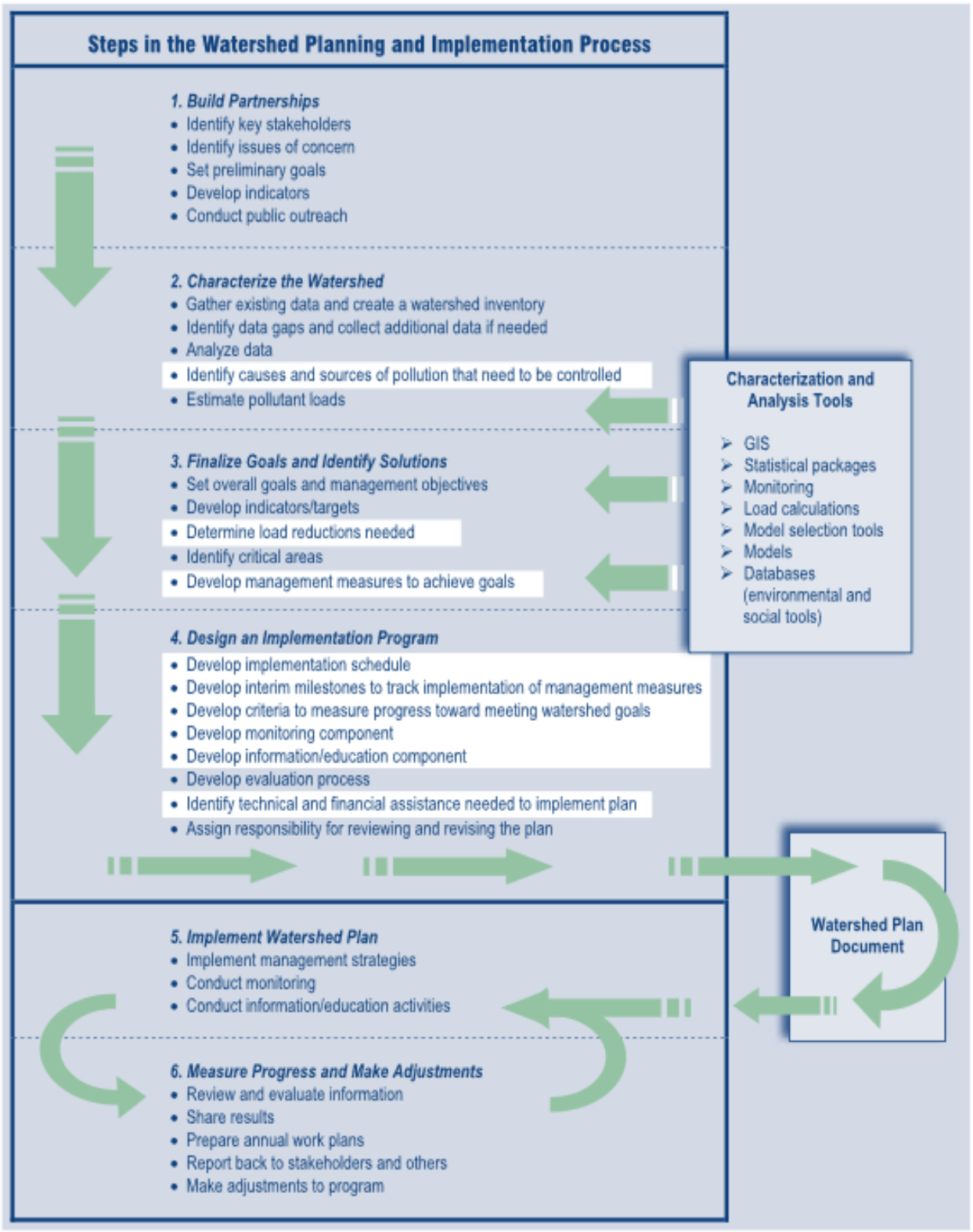
a. Costs

b. Timelines and Scheduling

c. Partners

d. Restoration Opportunities/Priorities

4. Monitoring and Evaluation


Steps in the Watershed Planning and Implementation Process
1. Build Partnerships
• Identify key stakeholders
• Identify issues of concern
• Set preliminary goals
• Develop indicators
• Conduct public outreach
2. Characterize the Watershed
• Gather existing data and create a watershed inventory
• Identify data gaps and collect additional data if needed
• Analyze data
• Identify causes and sources of pollution that need to be controlled
• Estimate pollutant loads
Characterization and Analysis Tools
➢ GIS
➢ Statistical packages
➢ Monitoring
➢ Load calculations
➢ Model selection tools
➢ Models
➢ Databases (environmental and social tools)
3. Finalize Goals and Identify Solutions
• Set overall goals and management objectives
• Develop indicators/targets
• Determine load reductions needed
• Identify critical areas
• Develop management measures to achieve goals
4. Design an Implementation Program
• Develop implementation schedule
• Develop interim milestones to track implementation of management measures
• Develop criteria to measure progress toward meeting watershed goals
• Develop monitoring component
• Develop information/education component
• Develop evaluation process
• Identify technical and financial assistance needed to implement plan
• Assign responsibility for reviewing and revising the plan
Watershed Plan Document
5. Implement Watershed Plan
• Implement management strategies
• Conduct monitoring
• Conduct information/education activities
6. Measure Progress and Make Adjustments
• Review and evaluate information
• Share results
• Prepare annual work plans
• Report back to stakeholders and others
• Make adjustments to program

Self-Check –4	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: short answer. (10 point)

1. What is watershed planning(4pts)?
2. List and discuss at least four types of watershed plan (4pts)
3. Who prepare watershed development plan? (2pts)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 5points** **Unsatisfactory - below 5 points**

Information Sheet 5- Designing a strong watershed results framework condition

5.1. Designing a strong watershed results framework condition

Watershed condition is the state of the physical and biological characteristics and processes within a watershed that affect the soil and hydrologic functions supporting aquatic ecosystems. Watershed condition reflects a range of variability from natural pristine (functioning properly) to degraded (severely altered state or impaired). Watersheds that are functioning properly have terrestrial, riparian, and aquatic ecosystems that capture, store, and release water, sediment, wood, and nutrients within their range of natural variability for these processes. When watersheds are functioning properly, they create and sustain functional terrestrial, riparian, aquatic, and wetland habitats that are capable of supporting diverse populations of native aquatic- and riparian-dependent species.

Watersheds that are functioning properly have five important characteristics.

1. They provide for high biotic integrity, which includes habitats that support adaptive animal and plant communities that reflect natural processes.
2. They are resilient and recover rapidly from natural and human disturbances.
3. They exhibit a high degree of connectivity longitudinally along the stream, laterally across the floodplain and valley bottom, and vertically between surface and subsurface flows.
4. They provide important ecosystem services, such as high-quality water, the recharge of streams and aquifers, the maintenance of riparian communities, and the moderation of climate variability and change.
5. They maintain long-term soil productivity as healthy watershed.

Watershed condition classification is the process of describing watershed condition in terms of discrete categories (or classes) that reflect the level of watershed health or integrity. In the context of this framework, watershed health and integrity are conceptually the same. watersheds with high integrity are in an unimpaired condition in which ecosystems show little or no influence from human actions (Lackey 2001).
The Forest Service Manual (FSM) uses three classes to describe watershed condition (USDA Forest Service 2004a, FSM 2521.1):

Class 1 watersheds exhibit high geomorphic, hydrologic, and biotic integrity relative to their natural potential condition.

Class 2 watersheds exhibit moderate geomorphic, hydrologic, and biotic integrity relative to their natural potential condition.

Class 3 watersheds exhibit low geomorphic, hydrologic, and biotic integrity relative to their natural potential condition.

The FSM classification defines watershed condition in terms of "geomorphic, hydrologic and biotic integrity" relative to "potential natural condition." In this context, integrity relates directly to functionality. Geomorphic functionality or integrity can be defined in terms of attributes such as slope stability, soil erosion, channel morphology, and other upslope, riparian, and aquatic habitat characteristics. Hydrologic functionality or integrity relates primarily to flow, sediment, and water-quality attributes. Biological functionality or integrity is defined by the characteristics that influence the diversity and abundance of aquatic species, terrestrial vegetation, and soil productivity.

The three watershed condition classes are directly related to the degree or level of watershed functionality or integrity:
Class 1 = Functioning Properly.
Class 2 = Functioning at Risk.
Class 3 = Impaired Function.

In this framework, we characterize a watershed in good condition as one that is functioning in a manner similar to natural wildland conditions (Karr and Chu 1999, Lackey 2001). This characterization should not be interpreted to mean that managed watersheds cannot be in good condition. A watershed is considered to be functioning properly if the physical attributes are appropriate to maintain or improve biological integrity. This consideration implies that a Class 1 watershed in properly functioning condition has minimal undesirable human impact on natural, physical, or biological processes and is resilient and able to recover to the desired condition when or if disturbed by large natural disturbances or land management activities (Yount and Neimi 1990). By contrast, a Class 3 watershed has impaired function because some physical, hydrological, or biological threshold has been exceeded. Substantial changes to the factors that caused the degraded state are commonly needed to set them on a trend or trajectory of improving conditions that sustain physical, hydrological, and biological integrity.

The Six-Step Watershed Condition Framework

Step 1: Classify the condition of all level watersheds in the national forest by using existing data layers, local knowledge, and professional judgment.

Step 2: Prioritize watersheds for restoration: establish a small set of priority watersheds for targeted improvement equivalent to a 5-year program of work.

Step 3: Develop Watershed Restoration Action Plans that identify comprehensive project-level improvement activities.

Step 4: Implement integrated suites of projects in priority watersheds.

Step 5: Track restoration accomplishments for performance accountability.

Step 6: Verify accomplishment of project activities and monitor improvement of watershed and stream conditions.

A watershed framework - is simply a lasting process for partners working together. It's a support structure making it easier to coordinate efforts a structure made of agreed upon standard operating procedures, timelines, and forums for communicating with each other.

A state agency might be interested in major river basins since it's charged with assessing and managing water quality statewide. A local government wanting to protect its drinking water supply may need to work with neighboring jurisdictions throughout a medium sized watershed. A federal agency may need to implement a multiple use management plan on a watershed in public ownership. A local watershed association may be trying to solve a sedimentation problem in a small watershed. If designed well, the watershed approach links all these initiatives with state, local, and regional frameworks complementing and strengthening each other and individual projects

Figure : A watershed framework is a support structure that makes it easier for partners to work together.

Strong local level institutions at the grass roots level are crucial for successful watershed management. Watershed management requires coordination, comprehensive efforts, and a more direct involvement of local communities, government and non-governmental institutions, and other stakeholders. In the new institutional economics, institutions are viewed as durable rules which govern human interactions, and which are also 'humanly devised. Strong village-level institutions are a prerequisite for successful watershed management

Roles and Responsibilities - The Director of the Watershed, Fish, Wildlife Program Staff Office has the responsibility to

- Consult and coordinate with other Federal agencies to develop approaches and guidance for watershed delineation, watershed assessment, and classification of watershed condition
- Develop criteria and standards for classifying watershed condition for the Government Performance and Results Act (GPRA) assessment, forest plans, and program development.
- Develop criteria for determining and displaying watershed condition trends for the GPRA assessment, forest plans, and program development.
- Use the results of watershed condition analyses for the GPRA assessment and as a basis for defining needs and opportunities in the program alternatives.
- Develop policy and program direction and assign targets for the watershed improvement program

Regional foresters have the responsibility to

- ✓ Develop guidelines and procedures, based on national criteria and standards, for establishing priorities for assessing and monitoring watershed conditions and trends. Ensure that assessment and monitoring data are available in a corporate database. Provide technical and administrative oversight of the forest classification process.
- ✓ Determine how watershed condition will be integrated in regional, forest, an Work with States, tribes, and other interested parties to identify watersheds as priorities for protection, management, and improvement.

- ✓ Use economic and environmental analyses to help identify opportunities for improving and maintaining watershed conditions.
- ✓ Establish regional priority guidelines for watershed improvement projects.
- ✓ Establish and maintain a corporate database of watershed improvement needs.
- ✓ Provide training for personnel involved in watershed improvement planning, project implementation, maintenance, monitoring, and reviews project planning processes.

Forest supervisors have the responsibility to

- Assess (classify watershed condition) and monitor watershed conditions and trends and enter data into a corporate database.
- Work with States, tribes, local governments, and other interested parties to identify watersheds as priorities for protection and management and for improvement
- Coordinate watershed priorities and resource management activities on NFS lands to attain forest plan goals and objectives for watershed condition.
- Cooperate with other agencies, groups, and individuals whose plans or proposals affect watershed conditions on NFS lands.
- Maintain a watershed improvement needs inventory in a corporate database.
- Identify priority watersheds for restoration; develop and approve prescriptions]and plans for a forest watershed improvement program. Delegate the development of detailed prescriptions and plans to the district rangers when expertise is available at the district level.
- Ensure that funded watershed condition improvement projects are accomplished and that treatment measures are implemented as prescribed and approved

Self-Check –5	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: short answer. (10 point)

1. Define what watershed condition is (4pts)?
2. Write the three watershed condition classes based on the level of watershed functionality (3pts)
3. List at least three important characteristics of properly watersheds functioning (3pts)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 5points** **Unsatisfactory - below 5 points**

Information Sheet 6- Implementation, Monitoring and Evaluation of watershed

6.1. Implementation, Monitoring and Evaluation

Participatory implementation involved the progressive testing and validation of organizational and technical solutions to problems identified through participatory planning. This problem-solving process required a steady flow of information that allowed stakeholders to: monitor the project's implementation (i.e. refine plans according to practical contingencies); evaluate the process and outcomes (i.e. draw lessons from experience); and plan a new implementation cycle that took into account the findings of this evaluation. To facilitate the generation and use of this information, all experts made efforts towards establishing a participatory monitoring, evaluation and preplanning (PME) practice at the community level. Special attention was paid to identifying and testing criteria and procedures simple enough to be incorporated into the regular activities of farmers, grassroots organizations and local institutions. The project's community-level PME practice developed as an action-learning process involving both staff and participants. Project staff played a major role at the start of the process, but local participants progressively took over the responsibility for PME activities as the project progressed.

Participatory monitoring- consisted of the continued follow-up of the organizational and technical aspects of an activity's implementation. It was conducted by the local participants, with some support from project staff. Participatory monitoring paralleled the implementation process and was intended to enable participants and staff to conduct the following tasks:

- assess the progress made in implementation
- identify and address difficulties and constraints in implementation; and
- revise the implementation plans accordingly.

Self-monitoring- self-monitoring was considered to be a basic feature of the operating procedures of interest groups and community organizations. Promoting this practice was thus part of the project's assistance in building the managerial capacity of grassroots organizations. At the start of the project, staff facilitated self-monitoring, yet this type of support tended to be withdrawn once the group or organization became self-reliant. Self-monitoring by grassroots organizations focused on their internal operations (e.g. the participation of members in activities, the payment of association fees, the management of conflicts, task-sharing among group members, scheduling and logistical arrangements of working sessions).

Purpose of Monitoring

The purposes of monitoring watershed programs are as follows:

1. To carry out the analysis of the situation in the village community and the project and to determine whether the inputs in the project are well utilized.
2. To study the problems faced by the community in carrying out the project are identified to find a solution. And thereby it ensures that all activities are carried out properly by the right people and in time.
3. To determine whether project plan is suitable for solving the problem at hand.

Monitoring Tools

Numerous monitoring tools are available to determine the values of indicators over time. Some of the commonly used tools are as follows:

(a) Community workshops are arranged to evaluate the extent of performance and achievement.

(b) Farmers can record their simple and easily observable changes in their farms in logbooks. These records produce information in detail.

(c) Community may evaluate some technical indicators such as sediment yield, fodder productivity, change in quality of the living standard, crop productivity, involvement of self-help groups (SHGs) or user groups (UGs) etc.

(d) Geographical information system (GIS) is another monitoring tool which can provide lot of information

(e) Field indicators such as soil denudation, advance or reduction in gullies, land use

- Pattern and changes, channel scouring etc. are observed and measured.

(f) Remote sensing satellite imaginaries and aerial photographs are to be taken at the beginning of the project and it should be repeated periodically

(g) Video monitoring

(h) Hydro-meteorological data measurements

(i) Watershed modeling

Evaluation - gathers information from the observed data on monitoring and these are presented in a form which is easy to understand. Evaluation is an important aspect of watershed programs. It is a multi-dimensional task which is generally performed at different times during the implementation of watershed programs. Until recently watershed program evaluators tended to favor either a quantitative or a qualitative evaluation. Typically, quantitative evaluations reflect a simplistic view that reality takes a single form that can be perceived and measured objectively. On the other hand, qualitative evaluations reflect a more constructive view, implying that reality can have multiple versions.

There is a rising interest in mixing both the qualitative and quantitative methods of watershed program evaluation.

This comes from the fact that purely quantitative and purely qualitative approaches to watershed program evaluation both have limitations. The strengths of each evaluation often compensate for the weaknesses of the other evaluation.

After implementation of watershed management measures to overcome the watershed problems or fulfill the objectives the next step comes as evaluation of results obtained through them. The evaluation of watershed management work should be accomplished under the following two terms

- ✓ by achievement of watershed objectives
- ✓ financial returns

Both of these evaluations are necessary for assessing the efficiency of management work applied to the watershed. Several times, it is observed that, the protective benefits safeguard against misery and losses, which cannot be easily evaluated in terms of money. Under this circumstance, some financial values to put on them is required. The financial returns are evaluated in terms of cost-benefit ratio, which is determined by

accounting all the costs incurred for development work starting from survey work to implementation of the activities.

6.1.1. Scope of Watershed Program Evaluation

Monitoring is a process of continuous assessment of project activities in the context of implementing schedules. Monitoring takes care of day-to-day progress and management of the project. It is the regular observation and recording of activities taking place in the watershed project and also a process of routinely gathering information or data on all aspects of the project. Monitoring involves checking on how the project activities are progressing. It also involves giving feedback about the progress of the project to the donors/sponsors and beneficiaries of the project. The gathered data are used in making decisions for improving project performance.

Watershed development committee (WDC), Project implementation agency (PIA) and District rural development agency (DRDA) have special monitoring tools, system and tables for recording the monitored data. Thus, monitoring setup involves defining the objectives of monitoring system to design a program to systematically look after the achievements, to select the indicators, location, methods and frequency of observation and to organize, motivate and train people.

Evaluation Criteria

- **Relevance:** The extent to which the aid activity is suited to the priorities and policies of the target group, recipient and donor.
- **Effectiveness:** A measure of the extent to which an aid activity attains its objectives.
- **Efficiency:** Efficiency measures the outputs --qualitative and quantitative -- in relation to the inputs. It is an economic term, which signifies that the aid uses the least costly resources possible in order to achieve the desired results.
- **Impact:** The positive and negative changes produced by a development intervention, directly or indirectly, intended or unintended. This involves the main impacts and effects resulting from the activity on the local social, economic, environmental and other development indicators. The examination should be

concerned with both intended and unintended results and must also include the positive and negative impact of external factors, such as changes in terms of trade and financial conditions.

- **Sustainability:** Sustainability is concerned with measuring whether the benefits of an activity are likely to continue after donor funding has been withdrawn. Projects need to be environmentally as well as financially sustainable.

Self-Check –6	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I: short answer. (12 point)

1. What is the purpose of evaluation in watershed management? (5pts)
2. What is participatory monitoring in watershed management? (4pts)
3. What is self-monitoring? (3pts)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating – 6 points** **Unsatisfactory - below 6 points**

LG #60	**LO 3- Design appropriate benefit sharing mechanisms among stakeholders**

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Listing expected benefits of the watershed management
- Designing dynamic and continually re-adjustable benefit sharing mechanism

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, **upon completion of this learning guide, you will be able to**:

- list expected benefits of the watershed management
- Design dynamic and continually re-adjustable benefit sharing mechanism that allows accommodating changes

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets”
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1- Benefits of the Watershed Management

Introduction

Integrated Watershed development should have a benefit sharing approach. This means it involves integration of all stakeholders in all implementation stages. Thus, Watershed development should be benefited equally to all members of the community. These benefits may include environmental / ecological, economic benefits and social benefits. Sound Benefit sharing approach demands the engagement of watershed stakeholders. Our natural ecosystems are made up of forests, wetlands, water sources, plants and animals, and provide multiple goods and services that contribute to a healthy economy, environment and people. Every day, we rely on ecosystem goods and services they connect us to our environment.

1.1. Benefits of the Watershed Management

Some of the Benefits of Ecosystems

- **Benefits of Wetlands**: Improve water quality, regulate water flow for drought and flood management, provide wildlife habitat, provide carbon storage, contribute to climate change adaptation, provide opportunities for recreational fishing and hunting.

- **Benefits of Forests**: Improve air quality, absorb carbon emissions, filter air pollution, improve water quality and soil, provide important wildlife and bird habitat, provide sources of materials for building and manufacturing, provide shade and block winds.

- **Benefits of the Great Lakes**: Provide transportation, recreation and manufacturing goods and services contributing billions of dollars to Ontario's economy, source of drinking water for eight million people, provide raw power and cooling water for the province's energy supply.

- **Benefits of Green Spaces**: Create attractive, 'livable' communities by providing relaxing, walkable and aesthetically pleasing neighborhoods, help us to adapt to impacts of climate change, help prevent flooding and erosion, provide habitat for wildlife and birds.

- **Human Health**: A healthy watershed provides safe drinking water, provides food, enables us to adapt to the impacts of climate change more easily by cooling the air and absorbing greenhouse gas emissions, and provides natural areas for people to keep active and recharge our batteries.
- **Ecological Health**: A healthy watershed conserves water, promotes streamflow, supports sustainable streams, rivers, lakes, and groundwater sources, enables healthy soil for crops and livestock, and also provides habitat for wildlife and plants.
- **Economic Health**: A healthy watershed produces energy and supplies water for agriculture, industry and households. Forests and wetlands help to prevent or reduce costly climate change and flooding impacts, manages drought, contributes to tourism, fisheries, forestry, agriculture and mining industries.
- Focus on water quality goals and ecological integrity rather than on program activities.
- Improve the basis for management decisions through consideration of both point and nonpoint source stressors. A watershed strategy improves the scientific basis for decision making and focuses management efforts on basins and watersheds where they are most needed
- Enhance program efficiency. A watershed focus can improve the efficiency of water management programs by facilitating consolidation of programs within each watershed. For example, handling all point source dischargers in a watershed at the same time reduces administrative costs due to the potential to combine hearings and notices as well as allowing staff to focus on more limited areas in a sequential fashion.
- Improve coordination between federal, state and local agencies, including data sharing, pooling of resources, and coordinated assessment and control strategies.

- Increase public engagement. The Watershed Approach provides opportunities for stakeholders to increase their awareness of water-related issues and inform staff about their knowledge of the watershed. Participation is by way of public meetings over the five-year watershed management cycle as well as meetings at stakeholder's request. Additional opportunities are provided through the Department of Environment and Conservation homepage and direct contact with local Environmental Field Offices and social media.
- Greater consistency and responsiveness. Developing goals and management plans for a basin or watershed with stakeholder involvement results in increased responsiveness to the public and consistency in determining management actions.
- The Watershed Approach represents awareness that restoring and maintaining our waters requires crossing traditional barriers (point vs. nonpoint sources of pollution, county boundaries) when designing solutions. These solutions increasingly rely on participation by both public and private sectors, where citizens, elected officials, and technical personnel all have opportunity to participate. This integrated approach mirrors the complicated relationships in which people live, work and recreate in the watershed, and suggests a comprehensive, watershed-based and community-based approach is needed to address these.

Self-Check –1	Written test

Name…… ID……. Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I. short answer (10pts)

1. What is benefit sharing? (2pts)
2. List the benefit of watershed for ecosystem(4pts)
3. Wright the benefits of watershed in economic health(4pts)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Information Sheet 2- Dynamic and Continually re-adjustable benefit Sharing Mechanism

2.1. Dynamic and Continually re-adjustable benefit Sharing Mechanism

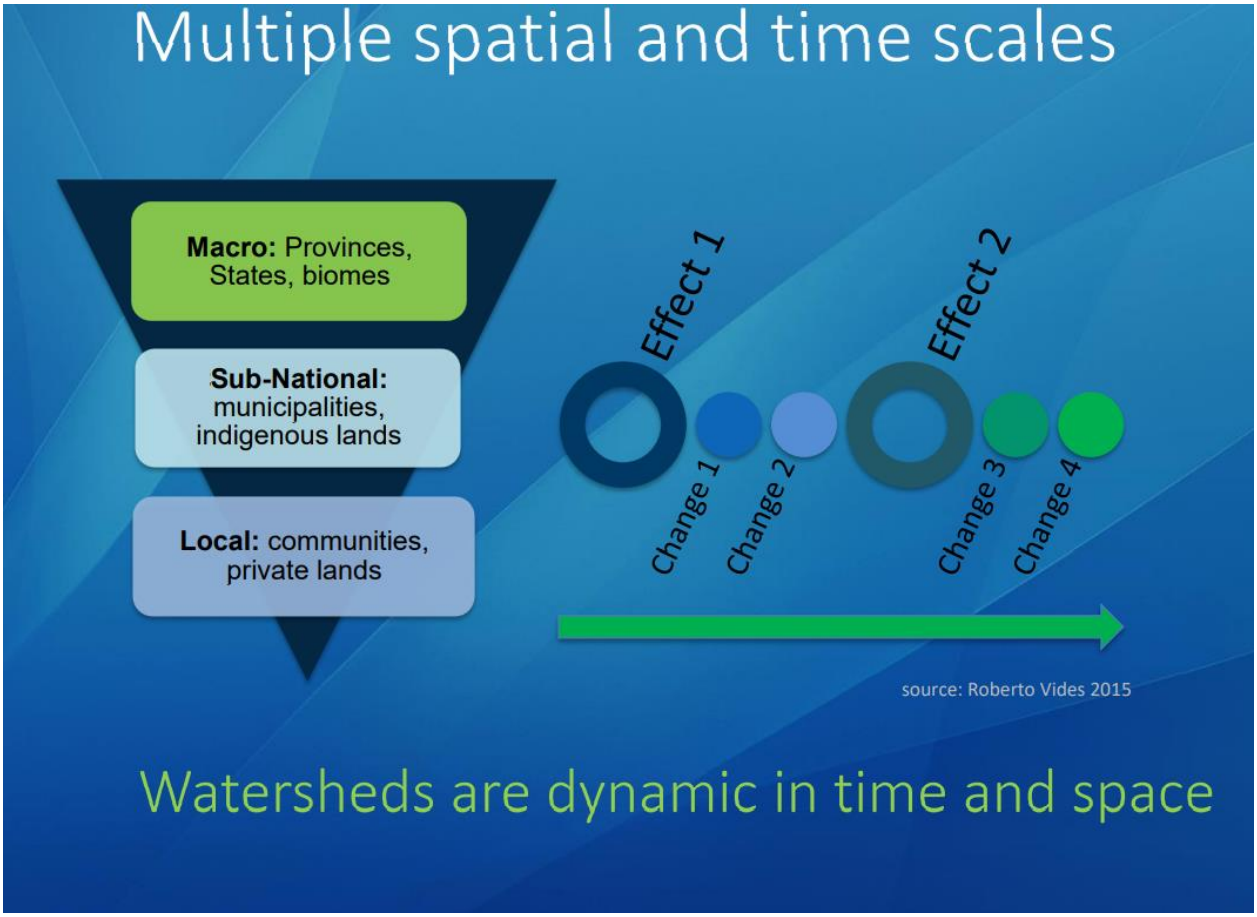
Benefit sharing refers to any action designed to change (optimize) the allocation of costs and benefits associated with cooperation. The process where riparian's cooperate in optimizing and equitably dividing the goods, products and services connected directly or indirectly to the watercourse, or arising from the use of its water. (Phillips & Woodhouse, 2015)

It enables integrity in the management of a watershed, Promotes the efficient and equitable management of the watershed, It can be applied to the management of other natural resources.

Users will share water cooperatively when they believe it is their best option. For this, the full range and true values of benefits and costs should be recognized in the assessment of alternative options. Benefit sharing enables win-win outcomes for multiple stakeholders in a basin and focuses on the distribution of benefits rather than only in water allocations

1.1.1. Benefits from watersheds & across watersheds

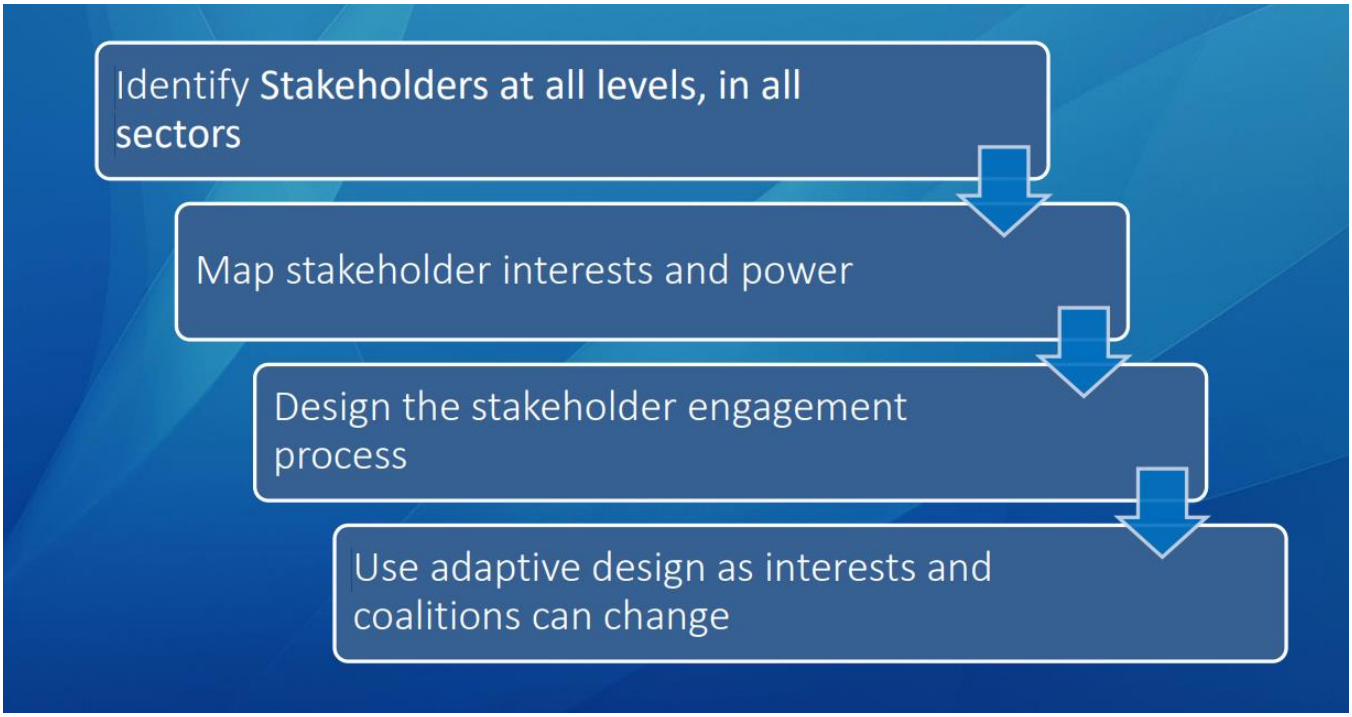
The watershed is the most useful spatial scale for water planning and management and also for assessing benefits



Benefit Sharing has 6 steps

1. Identifying stakeholders and equity issues
2. Identifying the array of benefits (existing and potential)
3. Building benefit enhancing scenarios
4. Quantifying costs and benefits from future scenarios
5. Negotiating benefits
6. Institutional agreements & implementation mechanisms

Stakeholder Engagement



Summary of Benefits Deriving from Cooperation

Types of Benefits	Challenges	Opportunities
Provide benefits *to the river/ basin* (environmental benefits)	Degraded water quality, watersheds, wetlands and biodiversity, ecosystem functions	• Flood control, drought mitigation • Erosion & sediment management • Wetlands and biodiversity conservation • Water quality & E-flows
Obtain benefits *from the river/ basin* (economic benefits)	Increasing demands for water, sub-optimal water resources management and development	• Increased yields • Enhances livelihoods, food security • Navigation, tourism, recreation • Carbon credits, PES
Derive benefits (avoid costs) *because of the river* (political benefits)	Tense regional relations and political economy impacts	• Cooperation, political stability • Policy shifts to food/energy security
Creating benefits *beyond the river/ basin* (e.g., greater cooperation in other realms)	Regional fragmentation	• Regional integration • Regional investment, development • Regional trade, market access • Diversified economies

From improved water management in the basin	Economic benefits	Social benefits	Ecosystem benefits
	• Increased activity, productivity and long-term sustainability in economic sectors (aquaculture, irrigated agriculture, mining, energy generation, industrial production, nature-based tourism) • Enhanced livelihoods and increased household incomes • Reduced cost of carrying out productive activities • Reduced economic impacts of water-related hazards (floods, droughts) • Increased value of property	• Positive health impacts from improved water quality and reduced risk of water-related disasters. • Improved access to basic services (such as electricity and water supply) • Social welfare from increased employment and reduced poverty • Improved satisfaction due to preservation of cultural resources or access to recreational opportunities.	• Preservation of aquatic and terrestrial habitats and biodiversity • Preservation of key bio-physical processes, e.g. e-flows • Better carbon management • Ecosystem resilience and enhancement of natural infrastructure

From enhanced trust in and beyond the basin	Regional economic cooperation benefits	Peace and security benefits
	• Development of regional markets for goods, services and labor • Increase in cross-border investments • Development of transnational infrastructure networks (transport, energy) • More diversified economies	• Shared basin identity • Reduced risk and avoided cost of conflicts between water users and between countries • Strengthening of international law • Increased geopolitical stability and strengthened diplomatic relations

Self-Check – 2	Written test

Name…… ID…… Date…….

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Part I. short answer (14pts)

1. Write down the economic benefits of watershed (4pts)
2. Write down steps of stakeholder engagement (4pts)
3. Write steps of benefit sharing (6pts)

You can ask you teacher for the copy of the correct answers.

Note: **Satisfactory rating - 7points** **Unsatisfactory - below 7 points**

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