Lecture notes

on

Soil Conservation and Watershed Management (WME 557)

(Kathmandu Forestry College, KAFCOL)

Unit 1. Integrated Watershed Management

Watershed : Watershed literally means it sheds " water ". Experts have defined it in various forms. Watershed is defined as :

- Topographically delineated area that is drained by a stream, and a major river basin as a collection watershed (Brooks, 1993).
- Total land area that is drained to one point of a stream or a river.
- Watershed as a natural drainage area where precipitation is collected and cycled. It tied together physically by an inter-related stream pattern (Eren,1983).
- Watershed is a unit of land catching precipitation and serving to move and concentrate water at some lower elevation (Krygier, J.T. 1963)
- Watershed is made up of the natural resource in a basin, especially the water, soil and the vegetative factors (Eren, T. 1977)
- A watershed or catchments is any surface (varying from a few hectares to several thousand square kilometers) in which rainfall is collected and conveyed to a common natural waterway (Botero, 1983)

Watershed is an ideal natural unit over which hydrological processes are integrated and for which a water balance may be constructed to show the disposal of precipitation into a number of subsequent forms i.e. interception, soil moisture and ground storages, evapo-transpiration and run-off. Also, watershed approach is logical for evaluating the biophysical linkages of upland and downstream activities, this approach is holistic and environmental impacts can readily be evaluated (Eastern and Brooks, 1985).
Watershed, catchments, drainage basin, river basins are interchangeable and used commonly as per management objectives. However, a watershed is differentiates from a river basin in that a river basin, whose main stream leads to the sea, may encompass hundreds of watersheds and many other types of land formation (Sheng, 1990)

Integration : Integration is to combine many elements into a whole i.e a complete. Integration is planning for a complete management of diverse land and water resource to obtain integrated benefits to conserve soil and water.

Integrated watershed management

1.1 Objectives, Concept, Approach and Scope

Objective :

Integrated management objectives is to develop more than one resource with due consideration to the inter-relations and interactions among the respective components (Eren, 1983). It can simply be defined as using the watershed for more than one purpose, simultaneously or sequentially, with due attention to the interaction among various uses with the aims of obtaining greater sustained production and of securing immediate and long term benefits (Botero,1983). Brooks (1985) defined integrated watershed management as a process of formulating and carrying out a course of action involving the manipulation of *natural, agricultural and human resources* in a watershed to achieve resource objectives, taking into consideration the *social, economic and institutional factors* operating within a river basin or other relevant region. In the widest sense, integrated watershed management includes all resources in a watershed, both human and bio-physical resources.

Concept :

The triangular relationship among land, water, and vegetation is extremely delicate in a given watershed system, and each of the elements is inter- connected in such away that disturbance of one may altogether change the situation from productivity to disaster. The integrated watershed management concept is to harmonize the use of soil, water and vegetation in a way that conserves these resources and maximize their productivity. Therefore, integrated watershed management is termed as the process of formulating and carrying out a course of action involving manipulation of natural, agricultural and human resources on watershed to achieve resource objectives, taking into consideration of social, economic and institutional factors operating within the watershed.

The integrated concepts of watershed management provide a framework for sustainable development, while watershed management practices provide the tools for making that framework operational. Various institutional mechanisms -

regulations, market and non-market incentives, public investment - provide the means for implementing those practices.

Integrated watershed management is the process of guiding and organizing land and other resource use on a watershed to provide desired goods and services without adversely affecting soil and water resources. Embedded in this concept is the recognition of the interrelationships among land use, soil, and water, and the linkages between uplands and downstream areas (Brooks et al. 1991).

Developing integrated approaches requires an understanding of communities, their responses to various incentives, and an understanding of the physical environments in which communities exist. Knowledge of appropriate technical solutions and of institutions or mechanisms, legal and financial, to implement action programs is also required. All important aspects of the problem and all opportunities are considered.

In a integrated watershed management, a participatory, integrated, multidisciplinary and multi-sectoral approach is necessary. Social aspects such as gender issues, disadvantaged groups, distribution equity, and ownership should be dealt with. The holistic and joint efforts of communities and government agencies are needed. Good communication skills at all levels are equally essential to achieve the aim of integrated watershed management (Sharma, 1995).

Integrated watershed management requires decentralization and linkages between central, district, and local-level organization and institutions. The success of a watershed management program depends on the simultaneous actions of several organizations, including the beneficiaries. Linkages with various organizations are imperative in order to achieve the goal of sustainable watershed management. In generals there are three different types of linkage mechanisms or relationships: (a) control, (b) influence and (c) appreciation (Sharma, 1995).

Approach :

Integrated watershed management is imperative in view of the continuing increase in population in contrast with the static nature of land surfaces. In addition, the management of resources in isolation is no longer acceptable or feasible for

meeting the constantly increasing demands for natural resources in greater quantity and quality (FAO, 1977).

A co-ordination mechanism is increasingly being considered as necessary for maintaining organizational linkages for carrying our watershed management programme. Experiences in watershed management lead us to believe that there are three levels of co-ordination activities : information sharing (maintain communication), resource sharing (transferring resources from the control of one organization to another), and joint action
(involves two or more organizations).

An integrated watershed management framework should generally be based on the practices that protect a watershed or prevent it from damage , reduce the effect of land-use to an acceptable level, and restore degraded environments for the benefit of the people living in them (Wagley, 1995).

Integrated watershed management technology is a combination of various techniques and institutions; therefore, the preventive, mitigative and restorative practices of watershed management should be accepted and implemented jointly by farmers or land users, communities and government organizations.

The institutional aspects of watershed management include the question of improving interagency co-operation. Inappropriate institutional arrangements and inadequate institutional capacity are common causes of shortfalls in watershed management projects and programmes (Wagley, 1995).

In Nepal, integrated watershed management is centered on the broad focus of resource conservation. The rational utilization of land and water resources for sustained economic development without degradation is the main aim of integrated watershed management.

The integrated approach of development project was encouraged by UNDP in the early 1960's, while the integrated approach in watershed management in Nepal was developed during 1970's.

Scope :

- It combines ecosystem and social system.
- It considers the bio-physical, social, economic and institutional factors necessary for the development of sustainable management programs.

- It provides a framework for consideration of human interaction with the environment.
- It can dealt bio-physical situation effectively.
- It is holistic/integrated (involve variety of practices)
- It warrants upland and downstream linkages in physical, social, and economic
- It is subtle and involve the sustainable development management strategies of programs
- It eliminates conflicting demands
- It helps close production gaps
- It overcomes problem of scarcity
- It generates multi-use benefits and employment
- It promotes balance in resource use
- It enhances community co-operation and co-ordination

1.2 Watershed as a Management Unit

Watershed as a management unit because sustained land and resource management depends on the interaction of all the activities that take place throughout the watershed. For instance : uplands and lowlands are physically linked in a watershed. Upstream activities affect downstream opportunities and problems by influencing the flow of water, sediments and other waterborne materials through the watershed system. Poor land use practices in the upstream not only leads to long term loses of upland productivity but also causes disaster in the downstream.
Similarly, a watershed allows assessment of the environmental effects and impacts of development including land-use activities both upstream and downstream. Thus, the effects of land-use activities and disturbances in upstream such as road construction, quarrying, logging, etc, which often result in a chain of downstream consequences, which can be readily examined and evaluated at any point within a watershed framework.
There are social, economic and institutional linkages with all facets of resource management and utilization in a watershed system. How these facets of watershed are managed likely to have impact on livelihoods of watershed inhabitants.

Therefore watershed as management unit, but the management objectives of these watershed varies in great extent. These management objectives guide the approach of watershed. Management objectives could be many such as: soil conservation ,water supply, forest management, rangeland management, hydro-electric dam/reservoir, agriculture production etc. However, the single objective approach

may not be appropriate but the multiple objectives will be necessary in such a way that they are environmentally and economically sound and socially acceptable.

1.3 Watershed characteristics :

Soil, geology, climate, land-use, land capability, socio-economic, geomorphology are important characteristics of watershed since they largely determine the watershed condition.

1.3.1 Soil : The knowledge of soils, their physical and chemical properties are imperative since it helps understanding the soil fertility and productivity of land in watershed. Soil particles and their sizes are important factors for soil erosion. The detachability and transportability of soil in the erosion process increase or decrease based on kind and size of soil particles. For example, the clay particles difficult to detach than sand but easier to transport. Soil with large stable particles such as sand grains or iron cemented soil particles are difficult to detached and transported, which seldom erode.

Infiltration capacity of soil play important role in soil erosion. Infiltration which is indirectly affected by permeability of different soil horizon is factor governing runoff and then to erosion. When rainfall intensity exceeds the infiltration capacity of soil then runoff or overland flow occurs, which causes erosion. If the infiltration capacity of soil is higher than the intensity of rainfall, then the runoff or overland flow will be lower and less erosion occurs.

Highly fertile soils result in high crop yields, good plant cover and, therefore, in conditions which minimize the erosive effects of raindrops, runoff and wind. These soils have a stable, usually granular, structure which does not break down under cultivation, and a high infiltration capacity. Soil fertility can thus be seen as the key to soil conservation.

High organic mater contents in soil improves the cohesiveness of the soil, increases its water retention capacity and promotes a stable aggregate structure.

1.3.2 Geology: It is an important characteristic of watershed. Weak geology of the watershed combine with rainfall lead to various forms of landslide in the watershed. In Nepal it is estimated that about 75 % of the landslides in the watersheds is due to the weak geology combined with human activities. Lithology and structural characteristics of geology need to be identified, which influence landslide in the watershed. Lithology is an study of rock type and understanding of mechanical properties of rock

joints, planes, faults, joints, slope gradient, orientation etc. are structural characteristics of geology. For example, the rock types like gneiss, mica schist, phyallite, limestone, sandstone are said to be susceptible to landslide based on their formation and orientation of joints, planes and folds.

1.3.3 Climate : Rainfall and temperature play pivotal roles in watershed condition. There is a direct relationship between the amount of rainfall and erosion in watershed. Rainfall intensity influences both the rate and volume of runoff and then to scale of erosion.

Temperature affects climatic type, which governs the types of crop grown and the amount of ground cover that exists in watershed. Temperature is important in producing desired level of ground cover to protect soil from erosion and landslides in the watershed. In highlands, maintenance of desired level of ground cover is difficult because of low temperature and short growing season of plants. In such watersheds, the intense rain can cause severe erosion. Similarly, because of warm temperature in the watersheds of arid regions results in more rapid decomposition of organic matter, which makes the soils low in organic matter content. This low of level organic matter content in soil makes the soil more susceptible to erosion during intense rains.

South facing slopes gets more sun directly than the slopes of other aspects. Because of high radiation and temperature in southern aspects, soils of southern aspects are lower in organic matter than those facing in northern slopes. Because of the low organic matter content in soil and sparse vegetation cover in southern aspects, the southern aspects are more susceptible to erosion than other aspects.

1.3.3.1 Climatic zones of Nepal : (MPFS, 1982 ; Forest and vegetation Types of Nepal, DoF, 2002)

Climate of Nepal is not controlled by latitudinal effect. Nepal does not fall within tropical and temperate latitudes. Its climate is determined by altitudinal gradients. The position of Himalaya
along with wide and varied topography of Nepal has determined a wide range of climatic zones. The followings are broad climatic zones of Nepal :

- **Tropical zone** --This zone extends throughout the Terai, the Bhabar and the flat floors of Dun valleys and low lying river beds and terraces (Tar). It lies

between the altitude of 70-1000m. It has a hot summer and the mean annual temperature does not fall below 20 C and the annual monsoon rainfall varies from 1000-1500 mm with a prolonged dry season.

- **Sub-Tropical Zone** -- This is a hot monsoon zone lies between the altitude of 1000-2000 m. It occupies the lower portion of the main Himalaya, the middle portion of Mahabharat range, and the upper portion of the Siwalik range, in which summer is hot and wet and winter mild and dry.

- **Temperate Zone** -- This type of climate prevails in the higher and lower middle mountains up to an elevation of 2000-3000 m. The summer is warm, mild and wet and winter is cool and dry.
  This zone is diverse in terms of landscape, forest habitats or agro-ecological zones. Over 40 % of the vegetation types of Nepal occur in this zone.

- **Alpine Zone** -- This zone falls in the high mountains, up to an elevation of 3000-5000 m. Low atmospheric pressure, low temperature and a higher degree of solar radiation provide environment conditions for alpine vegetation. The summer is cool and the winter is extremely frosty

- **Arctic or Tundra Zone** -- This type of " arctic or tundra" climate prevails in the high Himalaya above 5000 m, the snow-line where there is perpetual frost, snow and low precipitation.

1.3.1.2 Agro-Climatic Zones of Nepal :

Agro-climatic Zones of Nepal are classified based on the parameters like temperature, rainfall and altitude. These parameters control over the growing season and growth of agricultural crops. For instance, crops grow slow and growing season shortened in the areas having low temperature and low rainfall. Growth of crop and production will also be affected in the areas having high temperature and low rainfall. Similarly as the altitudinal variation exists there will be variation in air temperature and solar radiation which will have significant impact on crop growth and growing season. A linear relationship between altitude and mean annual temperature has been established. The linear relationship between elevation and the temperature is $T = 25.3822 - 0.0054 E$, (T= mean annual air temperature, E = elevation gradient), which entails that as the elevation increases, mean annual temperature decreases.

The crop growth, growing seasons and production are also dependent on other factors such as natural, physiographic and human factors. The natural factors are : solar radiation, snow, relative humidity, soil and geological condition etc. The physiographic factors are : topography, aspects, slopes and the human factors are : use of irrigation, fertilizer, seeds, equipments, organic mater, manure, farming practices etc.

However, based on the mean monthly air temperature, altitude and annual rainfall Nepal's agro-climatic zones are divided into seven different zones. They are :

- **Lower Sub-Tropical Monsoon Zone**: the altitude is < 800m., mean annual temp. is > 21c and rainfall is >1000mm
- **Upper Sub-tropical monsoon Zone** : altitude varies from 800-1200m, mean annual temp. is 19-21c and rainfall >1000mm
- **Warm temperate Monsoon Zone** : altitude varies from 1200-1900m, mean annual temp. is 15-19c and rainfall > 1000mm
- **Cool temperate Monsoon Zone** : altitude varies from1900-2800m, mean annual temp. is 10-15c and rainfall < or >500 mm.
- **Subalpine Monsoon Zone** : altitude varies from 2800-4100 m. mean annual temp. is 3-10c and rainfall < or >500 mm.
- **Alpine monsoon Zone** : altitude varies from 4100 - 4700 m. mean annual temp. is 0-3c and rainfall scattered
- **Arctic Zone** : altitude > 4700 m. Mean annual temp. < 0c, rainfall is scattered, heavy snowfall and perpetual snow.

The Land use by Agro-climatic Zone is given as below :

Land use by agro-climatic zone, 1986

Land Use	Agro-climatic Zone (Area in 1 000 ha)						
	High Mount.	High Hill	Mid Hill	Siwalik	Terai	Total	Percent
Agriculture Area	7.8	244.4	1 224.6	268.0	1 307.9	3 052.7	20.7
Percent	0.3	8	40	8.7	43		
Forest&Afforestation Area	154.5	1639.0	1806.4	1438.4	474.4	5 512.7	37.4

Percent	3	30	33	26	8		
Pasture / Meadow Area	884.8	508.0	279.6	16.3	58.0	1 746.7	11.8
Percent	51	29	16	1	3		
Shrub & Degraded Area	66.7	175.7	406.6	30.8	29.2	709.0	4.8
Percent	9	25	58	4	4		
Non-agricultural use Area	1.9	147.7	666.7	57.5	124.3	998.1	6.8
Percent	0.2	14.8	66.8	5.8	12.4		
Other uses Area	2 233.8	244.5	59.5	74.8	116.7	2 729.3	18.5
Percent	82	9	2	3	4		
All Total Area	3 349.5	2 959.3	4 443.4	1 885.8	2 110.5	14 748.5	
Percent	23	20	30	13	14		100

(Source, CES, 1998)

1.3.1.3 Factors affecting micro-climate patterns

Micro-Climate :
This is a local climatic condition of a given pocket or specific area, which is based on great variations of land use, land form and physiography. In Nepal, there is a great variety in microclimate because of vast changes in land-use, land form and physiography. It has been said that at each 100 m. elevation differences in mountain and hills in Nepal, there is a change in micro-climate. Variation of florestic composition at altitudinal change reflects the variation in micro climate. There are several factors affecting micro climatic condition of a given area.
Factors affecting micro-climate patterns :

The most influential factors for creating variation of micro climate are light / radiation (temperature), humidity, wind and frost. Where as the factors that create the micro climate are : air drainage, aspect, slope, vegetation, soil etc.

Light/ Radiation : Southern aspect receive more light and radiation than northern aspect. Reaching light and radiation also vary in east west faces and ridges

Slope : Steeper the slope, more pronounce are the variation of light and radiation, evapo-transpiration, soil moisture content and so on.

Air/wind : In deep valleys and shallow basins , the drainage of air/wind is limited or poor and fluctuates . These areas are usually foggy and temperature also tend to fall than the normal mountain slope. Local wind in mountain region varies, which affects temperature in the areas and there by affects the suitability of crops.

Vegetation : Vegetation patterns changes as micro climate changes and vice-versa. Areas having vegetation and water source are generally cool and humid than the area where vegetation and water source are absent. Temperature, humidity also differs and makes the area different from other.

Soil : Stand of vegetation and types differs according to the condition of soil. As vegetation patterns changes, there will be change in micro climate.

Frost/ hailstone : Occurrence and frequency of frost and hailstone is different and random in different physiographic zones, districts, valleys and bottoms which also affects micro climate.

1.3.4 Land-use :

- land-use assignments must be made which require that land capability and suitability be determined and that management practices be matched accordingly.
- human pressure creates the need for more efficient, diversified and sustainable systems of land use. Use of agro-forestry in marginal land, forest management, water management, recreation, pasture/grazing management, agriculture, conservation farming, multiple use.
- indigenous agro-forestry and terracing are traditionally practiced land-use practices in Nepal.
- increase in population led to competition in land-use for basic needs.
- forest land-use is in dilemma between agriculture and infrastructure development, settlement of landless people and encroachment
- appropriate land-use is the optimum use of land based on its suitability and capabilities without impairing natural environment and making sustainable economic and social benefits to the people.
- Any use of land beyond its carrying capacity and suitability leads to environmental degradation.

Land represents major natural resource of Nepal. About 90 % population of Nepal is based on land resource. Land Resource Mapping Projects (LRMP) prepared land use maps for the whole country (: 50,000) is being used by Department of Soil Conservation and Watershed Management.

Land-use of Nepal is categorized into Forest, Agriculture, Grassland, Shrub land, Water, Non-cultivated and others. Percent cover by different land use are:

Agriculture = 3 m. ha = 21 %

Forest = 4.27 m. ha = 29 %
Grassland = 1.7 m. ha = 12 %

Shrubland = 1.56 m. ha = 10.6 %

Non-cultivated = 1.0 m. ha = 7 %

Water = 2.6 %

Others = 17.8 %

Agriculture plays crucial role in Nepalese economy. Agriculture has supported 42 % of country's GDP. About 91 % people's livelihoods depend on agriculture and related activities. Agriculture has contributed both immediate and long term needs of rural community.
For subsistence living in mountain, one household needs 1 ha. of cultivated land and in hills and Terai one household needs 0.5 ha. agriculture land. Nepal's subsistence agriculture is based on forests products for fodder, wood, manure fuelwood and water.

Forests land are those which are pre-dominantly or partially covered by forests (including grassland, waste land fallow government land excluding legally cultivated land). Forests of Nepal in terms of management is further classified into National Forests, Private Forests, Religious Forests, Protected Forests and unallocated Forests. National forests are further divided into community forests, leasehold forests, collaborative forests. National forest are forests own by and managed by government. Private forests are owned and managed by individual or families. Tress and forests products are owned by the landowner. Religious Forests are own by religious groups and administered under Guthi Act.

In terms of cover and wood, Nepal's Forests resources are categorized into four different types.

Coniferous Forests (75 % or more number of trees in stand is conifers)
Hardwood Forests (75 % or more number of trees are broad leaved)
Mixed wood Forests (all combination of trees)
Shrub vegetation type

1.3.5 Land capability :

Land capability is the foundation of proper land use. Use of land without knowing its capability and suitability lead to degradation of land and entire watershed. The land capability is the use of land within its capability. For a given piece of land with its physical and climatic characteristics such as soil, slope, geology, climate etc. only certain land-use type can be adopted without degrading the land

1.3.5.2 Land capability Classification

The concept of land capability classification was first introduced by Soil Conservation Services of USDA in 1930s. Many criteria have been developed for land capability classification. In land capability classification, factors generally need to be considered are: slope, climate, geology, soil type/depth, stoniness, rockiness, wetness, gully dissection, frequent erosion /landslide/ flooding etc.

Land capability and suitability are sometimes exchangeable, however, the land capability is to prevent the land from degradation and abuse and land suitability is the fitness of a given type of land for a defined use.

All lands will not have same sorts of limitations. Certain lands will have more limitations than others. For example, land having shallow soil, steep slopes and harsh climate will have limited use and do not support all types of land use. Similarly, the land in flat or gentle slope with deep soils and favorable climate will not have many limited uses and do support for many uses.

Land capability classification is imperative for :

- knowing the best/proper use or practice
- intensity of use for the best practice

- precaution to be used for management
- conservation measures required
- limitations of use
- risk of adopting the use

USDA Broad Land Capability Classification :

USDA's eight broad land capability classification is based on the potential of soil, limitation for sustained production, risks of soil damage and erosion hazard. They are :

Class I : Soils having few limitations that restrict their use.

Class II : Soils having some limitations that reduce the choice of crops or require moderate conservation practices.

Class III : Soils having severe limitations that reduce the choice of crops or require special conservation practices or both.

Class IV : Soils having severe limitations that restrict the choice of crops or require very careful management or both.

Class V : Soils having little or no erosion hazard but have other limitations that are not practical to remove and limit their use largely to pasture, range, woodland or wildlife and natural cover.

Class VI : Soils having severe limitations that make them generally unsuitable for cultivation and limit their use largely to pasture or range, woodland or wildlife and natural cover.

Class VII : Soils having very severe limitations that make them unsuitable for cultivation and that restrict their use largely to grazing, woodland or wildlife.

Class VIII : Soils having limitations that prevent their use for commercial plant production and restrict their use to recreation, wildlife or water supply and aesthetic purposes.

Sheng, 1971 has developed land classification for upland cultivation. This classification is based on soil depth and slope %.

Land Classification for Upland Cultivation (Sheng, 1971)

Soil depth (cm)	Slope (%)				
	< 12	12 - 29	30 - 49	50 - 60	> 60
> 90	C_1	C_2	C_3	F_t	F
90 - 50	C_1	C_2	C_3	F_t / F	F
49 - 20	C_1	C_2 / P	P	F	F
< 20	C_1 / P	P	P	F	F

C_1 = Cultivable land, mechanization possible
C_2 = Cultivable land with intensive soil conservation measures, mechanization possible
C_3 = Cultivable land with intensive soil conservation measures constructed by hand tools
F_t = Fruit trees with orchard terraces
P = Pasture
F = Forest cover

Special cases : Land subject to water logging or frequent flooding : p
Stony land < 50 % slope : P
- 50 % slope : F

Land capability classification by LRMP

LRMP's land capability classification is based on soils, landform characteristics and climatic factors. LRMP has classified land into seven major classes, five sub-classes and five sub-divisions.

Class I : Nearly level (slopes < 1^0) , deep soils, erosion and mass wasting not problems. Limited use for arable agriculture or forestry development.

Class II : Gentle slope (slopes 1- 5^0), deep and moderately drained soils. No limitations for forestry and pasture development. Conservation measures are necessary when use for arable agriculture.

Class III : Moderate to steep slopes (5 - 30^0) , deep and well drain soils, mass wasting and erosion can be problems if not well managed. Limitation for forestry development. Grazing can not be encouraged. Conservation terraces are need if used for arable agriculture.

Class IV : Too steep slope for terracing, soil depth is more than 20cm., well drained, prone to erosion, mass wasting and flooding, too cold to be cultivated. Suitable for forestry development activities with adequate vegetation cover.

Class V : Slopes are $< 30^0$, soils are more than 20 cm deep, frequently flooded, too cold or dry to support forestry activities. Land is limited for the use of pasture with controlled stocking rates. Alpine and rain shadow regions above 3000m. and flooding alluvial plain falls within this class.

Class VI : Steep slopes, soil depth less than 20cm. chances of severe erosion. Land considered to have many limitations. Minimum use for food and fibre productions. Land should be maintained under vegetation cover.

Class VII : Rocky and icy. Rugged topography and terrain. Exposed bed rock and severe cold. Limited use for upland pasture.

Sub-classes :

Temperature regime based on altitudinal ranges are :
Sub-tropical (< 1000 m)
Warm temperate (1000 - 2000 m)
Cool temperate (2000 - 3000 m)
Alpine (3000 - 4000 m)
Arctic (> 4500 m)

Sub-divisions based on moisture regimes are :
Arid
Semi-arid
Sub-humid
Humid
Too-humid

Weakness / Limitation of LRMP's land classification:

- no mentioning of slope correction due to terracing and use of such land.
- classification is based on broad land system unit, so detail and specific analysis is missing
- classification is based on broad slope classes.
- no consideration of factors like : stoniness, rockiness and soil limitations.

1.3.6. Social, Cultural and Economic Factors

1.3.6.1 Socio-cultural

Besides economic activities, the information on the people's social and cultural norms and activities should be collected and analyzed for watershed management. Planner must carefully collect and study socio-cultural information before making any recommendations for drastic change. A mild and slow change at the beginning followed with continuing extension efforts is often the best path to pursue

1.3.6.1.1. Demographic

The debate about the impact of demographic dynamics on the natural resources dates back To Malthus, who warned about the earth's limited carrying capacity to support population growth. However, Boserup (1965) outlined the concept of agricultural intensification, which allows a given area of land to better feed an increasing population. These concepts include : 1.improving the productive capacity of already cultivated land by adding irrigation systems, soil and water conservation structures and so forth.
2. increasing the productivity of cultivated land by adding increased inputs and increasing the frequency of cultivation.
3. technical improvements, including new varieties of seeds and inputs which allow intensification and
4. shift to cash crops rather than traditional subsistence cropping, and livestock raising on marginal land.

Nepal's demographic concerns include rapid population growth, imbalanced population distribution, rapid and haphazard urbanization, increasing migration, high fertility and mortality. Population issues have so far been heavily viewed in the context of fertility reduction and family planning even though efforts have been underway over the past decades to take a more holistic and integrated approach. However, there is even greater need to view population in the context of the use and condition of natural resources systems, sustained economic growth, and sustainable development.

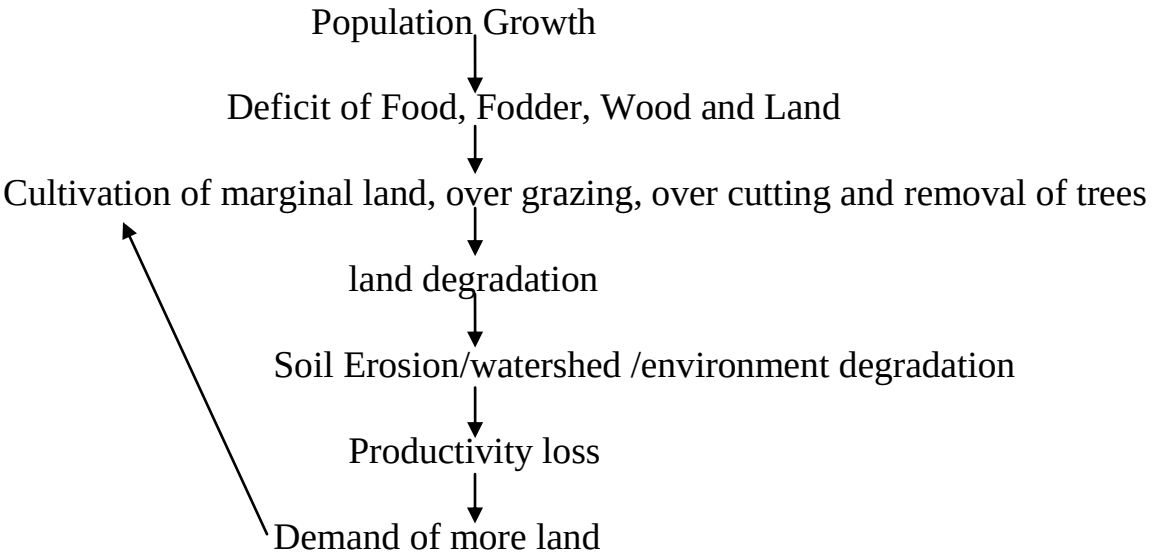
In Nepal differing views exist about the impact of population and increased scale of economic activities on environment, resources, and development. The interrelationship among population, resources, environment, and socioeconomic development are too complex and of a multidisciplinary nature to be amenable to a simple analytical treatment. Only a little is understood about the linkages, particularly at micro or community level. However, many now concur that rapid

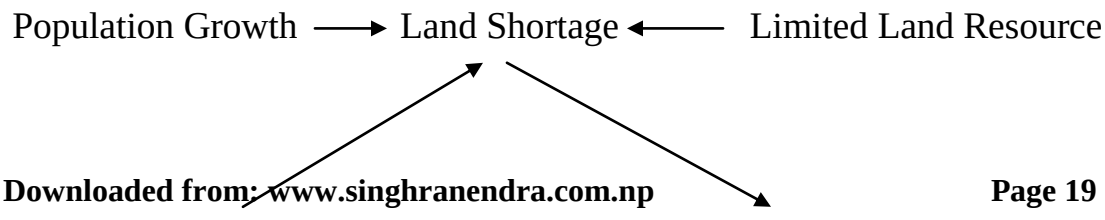
growth , high density, uneven distribution of population, and rapid and unplanned urbanization in Nepal has dampened the pace of socioeconomic development designed to enhance quality of life and maintain a healthy natural environment and a sound and sustainable natural resources base.

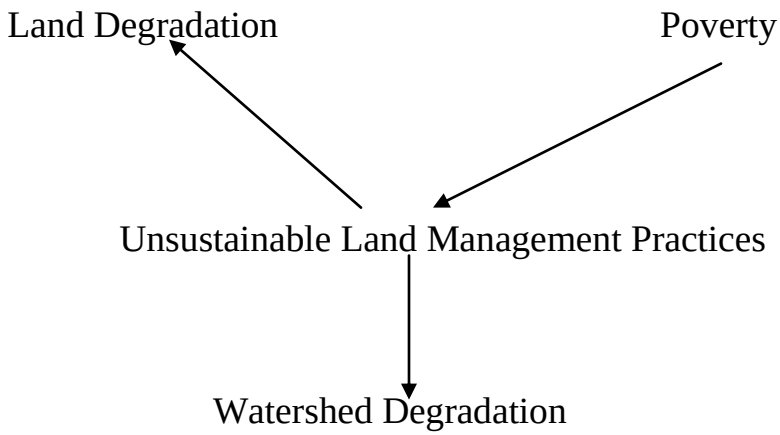
The search for sustainable development, conservation of natural resources and the environment, is influenced by population because the scale and intensity of human activities effects both . Population factors, in turn, are influenced by socioeconomic development, resource conditions, and environmental health. Consequently, sustainable development depend on whether population size, growth, and distribution can be brought in balance with the environment and technology-driven changes in the productive potential of ecological and life support systems at community, national, and global levels.

Considering the current population growth of Nepal, falling mortality and high fertility, the population growth of Nepal is likely to be high in the near future. This demographic structure together with the problem of technological stagnation, resource limitation and environmental deterioration may likely to have continuation of negative impact in watershed management. Consequently, population stabilization, farm innovations, resource conservation and environmental protection will be key factors shaping the sustainable management of watershed in Nepal.

Population growth in watershed results degradation of watershed and its environment. The vicious circle and the impact of population growth is as follow :







1.3.6.1.2. Cultural obstacles

Cultural information of watershed is equally important for the development of watershed management, since watershed management programs can bring cultural transformation in the society. These cultural transformation may sometime be dangerous in the majority of people inhabiting the watershed.

To consider local culture in planning is to minimize possible resistance in future implementation. Farmers are relatively conservative. Any improvement which is compatible with the local culture and with a gradual path will have better potential for success. For instance, bench terracing in upland areas is easily accepted in the Far East, where rice paddy is common.

Traditional practices have their roots in culture and society. Slash and burn shifting cultivation, for example, has been widely practiced in many parts of the developing countries. Other traditional practices such as uncontrolled grazing, use of fire to clear fields, and up and down tillage may have their reasons. Unless the farmers are provided with alternatives this practice will not easily be changed just by passing a law. Therefore, any substitution or improvement should stem from study or research and must be acceptable and beneficial both to those who apply it and to the environment.

Religious beliefs may affect the behavior and daily life of the local in rural watersheds. Religious beliefs exerts great influence upon local communities. The

best way to convince people is to work in close collaboration with religious organizations. Many educational campaigns and development activities can be performed from the religious and cultural groups.

Urban and rural relationships are usually equivalent to downstream and upstream relationships. Because of the wide cultural gaps, these relationships often present obstacles. For example, youth in rural areas are willing to take almost any job in town or cities, whereas urban youth, even when unemployed, seldom can be attracted by farm work. However, the physical relationship between upstream and downstream areas of a watershed cannot be separated. Information and consideration should be given to methods for establishing closer links between the populations of the two areas.

1.3.6.1.3. Awareness and knowledge

.The process of erosion due to degradation of natural resources is a slow process, so people usually overlook its impact in environment and loss of productivity of land resources. For example, people usually ignore the rill and surface erosion, development of unproductive sub-soil due to continuous loss of top soil, loss in farm production each year etc. Local people are not aware of tons of soil loss from their land each year and their cost. They even do not realize the time, labor, efforts and other inputs they provide in their land for higher yield and production, are futile, since they are unaware of the facts that their lands are in a state of gradual process of degradation. Some people who are aware of soil loss and its consequences may not be able to invest on soil conservation because of their low level of economy. And there are some people with good economy but not aware of soil loss and its consequences are unwilling to invest to conserve soil for their own future benefits.

Therefore, launching awareness campaign and knowledge sharing on importance of land, soil degradation, productivity loss and their consequences are imperative in watershed management.

1.3.6.2. Economic

Among other factors, economic factors also play crucial role in soil conservation and watershed management. Market availability, economic class and their structure, migration, labor availability, tourism, local resources are some of the key economic factors responsible for watershed management.

Socio-economic information is highly essential in watershed management and planning. It generates information on social structure and condition, economic condition and activities, demographic situation (male – female population, population growth rate etc), land ownerships, settlement, farming practices, community development, culture, education, health, people need, occupation, job, local earnings, market availability, local institutions, migration pattern, labor availability, ethnicity, knowledge and awareness, education, demand and supply information of watershed resources, insecurity, uncertainties etc.

In the past, watershed planning and management were developed and designed based on bio-physical information alone and no attention were given to socio-economic relations and their information. Many of such watersheds without socio-economic information were found failed at implementation level. Management without socio-economic information will not help socio-economic complexities in watershed and there will be a high risk for inefficient utilization of resources and investment. Later on, information on socio-economic aspect have been included in watershed management.

1.3.6.2.1. Market availability

Main focus of watershed management is to increase the production of watershed resources. If farmers living within the watershed produce more agricultural production through adopting watershed management programs then the farmers want to sale the surplus production in the market. Farmers seek for markets. In rural areas, availability of markets to sale the products is a problem. If farmers do not get easy market to sale his products, they may decline to invest and adopt soil conservation practices in their farm for increase production. Market problem is not that serious for the people who live in the watershed close to urban areas. Availability of market is enough close to urban areas. Farmers can sale their products within the reasonable distance from the watershed, if it is close to urban area.

The next important element is the price of the products. Farmers should be able to sale their products at the price more than the opportunity cost i.e cost for labor and land. If the price of the products is less than opportunity cost then farmers may decline to adopt soil conservation measures in their farm for more production. In such a situation farmers may use their farms for other purposes that pay higher price than the price of the products.

In the watershed, where there is no scope of good market opportunities the development of co-operative concept among the communities to sale the farmers products could solve the problem of markets.

1.3.6.2.2. Economic Class Stratification

Soil conservation and watershed management programs need investment. The investments are in two types : investment in materials and investment in labor, in other words they are material and labor costs . For a mountainous country like Nepal, where labor is cheap labor cost is not a problem, but the material cost will be too high in order to carry out watershed management program. Investment in watershed management by a single agency either by government or a development partner is not affordable. Based on this fact, government has placed a policy of cost sharing in watershed management. This is a sharing of conservation cost by government, development partner and (beneficiary) local people.

Scale of sharing cost from local people depends upon the stratification of different economic class people. For a well economic class people sharing of conservation cost to improve their land is not a problem, since this class of people can share the cost if the benefits of conservation is economically or socially viable. However, majority of people who live in remote watershed areas are in poor economic class. These people can not share the conservation cost. Sharing in conservation cost for watershed management by the majority of the rural people having poor economic status can not be expected.

Therefore, development partners have developed norms as peoples' contribution without differentiating different economic classes. It has been said that this norms has benefited better economic class people more than the poor economic class . The poor people, who have holding more marginal land, unproductive and degraded agriculture land did not get any conservation benefits.

If the government policy of watershed management is to reduce the poverty and improve the livelihoods of the rural poor people, a separate, but robust policy on cost sharing and peoples' contribution need to be developed in order to provide conservation benefits to the poor economic class people living in the watershed area.

1.3.6.2.3. Outward Migration and Labor Availability

No watershed management and soil conservation work can be done in isolation and without peoples' involvement. Peoples' involvement in survey design, program planning, decision making, implementation, follow up, monitoring and evaluation

of watershed management projects/programs is imperative. In other words, peoples' involvement at all stages of project cycle is badly needed for sustainable management of any given project.

Due to lack of economic diversification and development works in rural areas, lack of job opportunities to the young and elderly people has been resulted. One of the serious reasons for outward migration of youth is lack of job opportunities. Further, people do outward migration because of insecurity. Resource less people for the search of food and shelter also migrates. Domestic unrest and conflict also makes the people migrates. There is an increasing trend of outward migration of local people in Nepal mostly to seek jobs. These increasing trends of migration of local people have resulted in shortage of man power in rural areas for planning, decision making, participation, implementation and monitoring of soil conservation and watershed management programs. Shortages of labor force to implement the programs in a district have forced the projects to shift to another place where there is availability of local people. Lack of labor availability in a district due to out migration has been a serious concern of development projects.

At some villages, there are only limited old women, men and children are left in houses who can neither play decision making roles nor can they involved as labor force to implement the programs. The process of out migration of youths and skillful persons from the watershed area has been a constraint for a participatory watershed management and soil conservation program. To retard the rate of out migration, it is essential to open up the economic diversification program in a district. Establishment of micro and macro enterprises and implementation of job oriented development activities may help reduce the process of out migration.

1.3.6.2.4. Tourism Impacts on Local Resource Use

Tourism is one of the major industries and income source of both government and local people. Different types of tourists visit Nepal for different purposes. Trekking tourists and mountaineering expedition are most common in Nepal. Some tourists travel mountainous parts to see the scenic beauty and enjoy the trekking.

For trekking tourists, most of the trekking routes are located in high altitudes and along the cold zones, which demand for the use of fire wood for cooking, washing and heating the rooms of hotels and lodges. However, it has been reported that local people are heavily and unsustainably used local forest products in tourism.

Along the trekking routes, because of market opportunities a lot of villagers have established tea stall and lodges and hotels which consume lot of forest products

basically the fire wood. Heavy collection and use of fuel wood by these lodges, tea stall and hotels result depletion of forests and environmental degradation.

In mountaineering expedition, large number of wage labor or porter need to be used. These porters and labor force use large quantities of forests products for cooking, heating and washing at their camping sites. These activities have also aggravated the process of forests depletion and environmental degradation in tourist spots and camping sites. Heavy use of trails by trekkers and porters; and abuse of vegetation cover of the surrounding areas have also resulted in soil erosion and environmental degradation problems.

The accumulation of solid waste in the trekking routes, trails and camping sites of tourists has created a big environment pollution problems.

In order to mitigate the environment degradation problem in trekking routes trails and camping sites, migration of people and encroachment of forests lands in the trekking routes should be discouraged. Provisions for the use of alternative energy should be strictly follow. Trekking routes, trails and camping sites should not be open or established in and around the ecologically fragile areas. Environment awareness programs and campaigns should be launched on regular basis. Environment and its degradation should be closely monitored by establishing local level committees among local beneficiaries. Plantation, conservation and protection of forests and bio-diversity should be emphasized.

1.3.7 Geo-morphology

Geomorphology is a study of the physical features of the earth and of the relation between the physical features and the geological structure beneath the earth. Geo-morphology is one of the important characteristics of watershed as it determines the level of landslide /erosion hazards in a watershed. Physical features of a watershed and its geological structure are important to learn before designing a watershed management plan.

Physical features such as : elevation, slope, aspect, glacial activities and climatic factures like temperature, rainfall, snowfall together with earthquakes and human-induced land degradation influence
Morpho-dynamics. Parameters such as climate (temperature, wind, precipitation), topography (elevation, slope, aspects and slope surface condition), lithology and orientation of rock bedding planes, vegetation cover and glacial activity

Elevation differences cause air temperature variations, which control snow accumulation and melting. The slope gradient determines the susceptibility to mass-wasting. South aspect, due to exposition to more solar radiation can cause snow melting rapidly than the north aspect. The effect of climate on the physical disintegration and weathering of the rocks is very important. Due to temperature fluctuations, physical weathering of bedrocks is enhanced by the effects of freezing and thawing. Physical disintegration of bedrocks along joint lines and bedding planes takes place.

Geo-morphological characteristics of watershed can be described through linear scale and ratio.

Linear Scale : This is a stream order, which is a measure of the amount of branching in a drainage system. This is used to relate with hydrological and erosional processes. The single channel or stream with no tributaries is counted as first order, the two first order channels or streams combine to form a channel or stream of second order and two second order channels or stream combine to form a channel or stream of third order and so on. Therefore, second order channel or stream has only first order tributaries and third order stream has only first order and second order tributaries and so forth.

Figure :

Bifurcation Ratio (R_b) : Bifurcation Ratio of any given stream order is the ratio of the number of stream of the given stream order to the number in the next higher order.

$$R_b = N_u / N_{u+1}$$

Where, N_u = Number of streams of given order U
N_{u+1} = Number of streams of next higher order U+1

Figures :

Generally, bifurcation ratio are found to be in the range between 2 to 5 with a mean value near 3.5. The bifurcation ratio of x means on the average there are x times as many channels segments of any given order as of the next higher order. When geology is reasonably homogeneous throughout a watershed, bifurcation ratio usually range from 3.0 to 5.0. High bifurcation ratio might be expected in watershed of steeply dipping rock strata where narrow strike valleys are confined.

Total Stream Number in the Watershed :

Total number of streams (N) of all orders in a watershed, if the bifurcation ratio (R_b) and trunk order (main stream, K) are known is :

$$N = R_b^k - 1 / R_b - 1$$

Length of Overland flow :

Length of overland flow is the distance over which runoff will flow before concentrating into permanent channels. length of overland flow is one of the most important independent variables affecting both the hydrologic and physiographic development of drainage basins.

$$L_u = 1/2\, D_u \left(1 - S_c/S_g\right)^{½} = 1/2\, D_u$$

Where, L_u = length of overland flow of the given stream order u
D_u = drainage density of the given stream order u
S_c = average channel slope of stream of order u
S_g = average ground slope

Length Ratio : The length ratio RL is the ratio of mean length Lu of order u to mean length of the next lower order Lu-1

$$RL = L_{\hat{U}} / L_{\hat{U}-1}$$

Where, $L_{\hat{U}}$ = Mean length of U order stream stream and

$L_{\hat{U}-1}$ = Mean length of next lower order

Arial Aspects of watershed :

Area

The area A_u of a basin of a given order u is defined as the total area projected upon a horizontal plane, contributing overland flow to the channel segment of the given order and including all tributaries of lower order. For example, the area of a basin of the u order, Au, would cumulate the areas of all first, second, ...and u-1 order basins, plus all additional surface elements, known as inter-basin areas, contributing directly to a channel of order higher than first.

Area of basin of U^{th} order (A_u) = areas of all 1,2,3,……u-1 order basin
+ inter basin areas contributing overland flow directly to a channel.

Figure …….

$$Au = \{\Sigma A1 + \Sigma A2 + \Sigma A3 + \ldots\ldots\ldots\ldots\ldots \Sigma A\ u\text{-}1\ \}$$

Area of watershed affects Tc (time of concentration)

As area of watershed (A) increases, the run-off volume (x) and rate of run-off (r) increases. However, the run-off volume and rate of run-off per unit area of watershed decreases.

For example: The watershed of area A has x and r run-off volume and rate of volume, i.e

A = x , r or, Unit area (1) = x ,r / A. Therefore, as A increases x and r per unit area of watershed decreases.

Unit 2 Desertification

2.1 Concept of the desert and desertification

Desert : Areas that receive less than 10 inches (25.4 cm) of rain a year are generally classified as deserts. Dry (arid) regions are usually found in area of high pressure (subtropical highs, leeward sides of mountains, etc.) associated with descending divergent air masses that are common between 30 degrees N and 30 degrees S latitude. As a consequence of low moisture, desert vegetation is sparse and specifically adapted to conserve water . Deserts are areas of high relief (e.g., mesas, buttes, etc). Desert regions typically feature well-sorted sands, often found in various dune formations shaped by sand type, moisture content, and eoilian processes. In desert areas, change usually occurs by some form of physical weathering . The wide diurnal temperature can make the modest amounts of moisture present powerful weather factors through continual freezing and thawing cycles that can result in micro-fracturing of rock . Winds often allow high levels of physical or frictional abrasion.

Desertification :

The United Nations' definition of "desertification" is: "land degradation in arid, semiarid and dry sub humid areas resulting mainly from adverse human impact." By 1984, as many as 13.5 million people worldwide were displaced from the land due to desertification. Hunger is increasing in the world due to desertification. Every day, about 33,000 people will quietly starve to death. The causes of desertification include overgrazing, deforestation **,** destruction of forests resources and increasing economic crises of poor countries,

The United Nations Convention to Combat Desertification (CCD) defines desertification as:

" land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climate variation and human activities" (UNCCD 1995)

The term 'desertification' makes one think of barren, desert like conditions. In addition to dry, sandy soils though it should be remembered that the CCD definition also includes other factors including biodiversity loss, ecological deterioration, disturbances of vital natural resources such as water supplies, poverty and the breakdown of human societies as a result.
'Land degradation' is a complex concept with many dimensions. Human are suffering from its causes.

As the major use of land in the dry areas, agricultural systems play a critical role in desertification and its frequent companion, drought. The poor in developing countries are especially hard-hit by these scourges, because they depend on agriculture for a bare living. In short, desertification, drought, poverty and agriculture are interdependent problems of enormous magnitude and worldwide extent**.**

2.2 Causes of desertification

Removal of vegetation

The immediate cause is the removal of vegetation. Unprotected, dry soil surfaces then blow away with the wind or are washed away by flash floods, leaving infertile lower soil layers that bake in the sun and become an unproductive hardpan. Overgrazing destroys valuable plant species, leaving mostly unpalatable ones. Losses of vegetation and biodiversity threaten habitat for other species.

But what causes the removal of vegetation? This is driven by a number of factors, alone or in combination, such as tillage for agriculture; too many livestock on too little land; removal of crop residues for feed/construction use; deforestation for fuelwood and construction materials; and inappropriate irrigation practices that lead to salinity.

Overgrazing

Overgrazing was not as large of a problem long ago because animals would move in response to rainfall. People would move with the animals so it prevented

overgrazing in such areas. Now, humans have a steady food supply so they do not have to move about. Therefore, people use fences to keep their animals in one place which causes overgrazing. (Desertification, 2001)

Farming of Average Land

Farming of average land (marginal land) is causing desertification worldwide. Farmers are clearing average land, and using it which takes away the richness in the soil. People should let the average land replenish itself before farming. (Desertification, 2005)

Destruction of Plants in Dry Regions

Destruction of plants in dry regions is causing desertification to occur. People are cutting down tress to use them as a source of fuel. Once all these trees are cut down there is nothing to protect the soil. Therefore, it turns to dust and is blown away by the wind. (Desertification, 2005)

Incorrect Irrigation in Arid Regions

Incorrect irrigation is commonly used in poorer areas. Farmers are using canal irrigation and other poor techniques because of the lack of water. This type of irrigation causes a build up of salt in the soil. (Desertification, 2005)

These proximate causes in turn are associated with a wide range of root causes, some of which originate outside the drylands. They include:

- **Drought :** The role of drought bears special mention. The threat of drought constantly looms over dry land agriculture. Drought depletes vegetative cover and may lead to human actions, such as overgrazing and the expansion of farmlands, that propel dry lands more rapidly towards a desert like condition. Increasing agricultural pressure on the land due to population growth also aggravates this downward spiral (Akhtar-Schuster et al. 2000). Drought and desertification are an intertwined nemesis in their daily lives.
- **Climatic shifts:** A major new threat is climate change (Hillel and Rosenzweig 2002). Modeling results suggest that dry areas could become hotter and drier, especially semi-arid Africa and South Asia (Parry 2002). If climate change increases the frequency and/or intensity of droughts, it would aggravate desertification.

- **Growing populations:** that increase pressure on fragile land resources; It has been argued that overpopulation leads to too many people farming too little land, degrading it in a downward spiral.

  But as populations and land pressure increase, too many animals overgraze and destroy the vegetation, starting the downward spiral of desertification.

2.2.1 Effects of desertification

- Deterioration of Soil :
  Soil becomes less usable. Soil can be blown away by wind or washed away rain. Nutrients in the soil can be removed or lost by wind or water. Salt can build up in the soil which makes it harder for plant growth. difficult to grow crops

- Destruction of Vegetation:
  Loosened soil may bury plants or leave their roots exposed. Also, when overgrazing occurs, plant species may be lost. Overgrazing also destroys vegetation and erosion occurs
- Famine :
  Places that have war and poverty are most likely to have famine occur. Drought and poor land management contribute to famine.

- Food Loss :
  The soil is not suited for growing food; therefore the amount of food being made will decline. If the population is growing, this will cause economic problems and starvation.

- People near Affected Areas:
  Desertification can cause flooding, poor water quality, dust storms, and pollution. All of these effects can hurt people living near an affected region. (The Facts of Desertification and United Nations Convention to Combat Desertification, 2000)

Desertification Process in Nepal :

Terai Region

Every day, 2000 trucks have been exporting sand and stone to India from Kanchanpur to Maorang. Nowadays, by the side of the southern boarder of Nepal, government of India is constructing highway. Stone and sand are cheap in Nepal,

so Indian contractors are buying it materials from Nepal. Export will certainly help to Nepali economy. However, it will increase desertification of Terai. Nobody is focusing impact of export of sand and granel on environment of Chure and Terai region. Collection of sand and gravel has deepening the level of river in some areas of Terai region. Irrigation system is not working in Butwal areas due to low level of water in some river. Next year, these problems will be increased rapidly in other parts also. In addition, breadth of river is increasing in Terai region

Chure area is fragile from the point of geological strcture. Its structure is weak. Nowadays, people started to take out stone from this reason. During rainy season, rivers which are flowing from these areas may leave soil and other debris in terai region. Agriculture land will be filled with such a unnecessary materials. In the end livelihood of farmer of terai region will be very much painful.

Government has made plan to implement Integrated Watershed Programme in Chure area. It has purpose Chure-Terai development programme. On the other hand, National Park and Wildlife Act and Regulation mentioned that only local people can use forest resources for their use only, not for commercial purpose. According to act, wood, stone are forest resources. People can not take these resources outside that area. It clearly shows that act has not given permission to use forest resources for commercial purpose.

It is time to study the situation of Chure-Terai region and find some area and quantity which can be taken or extracted. However, it would affect less for environment. On the other hand, revenue should be increased by making competition among buyers. Nevertheless, sustainable development should be prime concern.

More than 300,000 people in nine hill districts of far western and mid-western Nepal face a precarious food situation after the crops failed this year due to drought, the UN's World Food Programme (WFP) has warned.

Deforestation

Change in Forest Cover: Between 1990 and 2000, Nepal lost an average of 91,700 hectares of forest per year. The amounts to an average annual deforestation rate of 1.90%. Between 2000 and 2005, the rate of forest change decreased by 28.9% to 1.35% per annum. In total, between 1990 and 2005, Nepal lost 24.5% of its forest cover, or around 1,181,000 hectares. Nepal lost 42,000 hectares of its primary

forest cover during that time. Deforestation rates of primary cover have decreased 10.7% since the close of the 1990s. Measuring the total rate of habitat conversion (defined as change in forest area plus change in woodland area minus net plantation expansion) for the 1990-2005 interval, Nepal lost 7.9% of its forest and woodland habitat. If the forest and habitat loss increases then the problem of desertification will be more acute in Nepal in future

Unit 3 Land Productivity and Soil Fertility

3.1 Factors Affecting Production and Productivity

Production : Production is the outputs received from the activities that are implemented in one or more management units. It is also a output of a system, such as biological or economic outputs and entails the efficiency of management of a system. Production interacts and comprises with pattern of delivery of resources or inputs. Production is measured in terms of units like numbers, weight, volume etc.

Productivity : It is the amount of outputs per unit area from the given inputs. It is also referred as the rate at which goods or services are produced especially from the given pattern of delivery of resources. It is the ratio of the outputs of goods or services to the inputs. Productivity reflects the measures of : outputs from a production process per unit of inputs, value of production, stability (how it varies), sustainability (how durable it is) and equitability (how it shared)

Factors affecting land production/Productivity : There are various factors that affect land production and productivity.

- Climatic factors : rainfall, snow, temperature, solar radiation, wind
- Adephic factors : Soil nutrient, structure, fertility, moisture, water logging, salinization, acidification, chemic toxicity etc.)
- Bio-physical/Physical features : vegetation or ground cover and types, altitude, slope, aspect, erosion, fragility of land, land capability, accessibility,
- Management practices : land husbandry and inputs (seeds, fertilizer, irrigation, livestock grazing) farming practices etc.
- Demographic factors : population pressure, structure, land holding etc.
- Human activities : Abuse of land, over exploitation , encroachment

- Socio-economic factors : income, employment , education, health, social structure, social norms and values, migration, scarcity, poverty etc.
- Market/economics : scope and availability of markets, incentives, local economics etc.
- Policy consideration and Political factors : land tenure, land-use, land Act, ownership, decision making , rehabilitation, political pressure etc.

3.2 Nutrient management/Soil Fertility

Nutrient : The elements that plants need to survive are called nutrients. Nutrients are usually absorbed from the soil solution in the form of 'ions'. 'ions' are dissolved salts (nutritive salts)that have an electrical charge. Electrical charge in the dissolved salts are of two types : + ve charge particles called cations (ammonium $NH4+$) and - ve charge particles called anions (nitrate $No3-$ and phosphate $H2Po4-$)

Essential nutrients : Nutrients that a plant requires through the entire growth cycle. Deficiency of any of these nutrients will have consequences to the plant for growing, flowering, fruiting, seeding and producing bulbs. All the plants do not require equal quantity of all essential nutrients. Essential nutrients are divided into two groups :

- Macro nutrients : Plants require these nutrients in large amount for their vigor and growth. These nutrients are Carbon (C), Hydrogen (H), Oxygen (O), Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca) , Sulphur (S), Magnesium (Mg)
- Micro nutrients : plants require these nutrients in small amount. These nutrients are : Iron (Fe), Manganese (Mn), Boron (B), Zinc (Zn), Cupper (Cu), Molybdenum (Mo)

Nutrient management : Nutrient management is to ensure sufficient nutrients both the macro and micro nutrients supply to the plants for their vigor and growth. Plants uptake nutrients from soil so we need to keep nutrient balance in the soil. In other words, loss of nutrient from the soil has to be minimized and need to add adequate nutrient in the soil for the benefits of the plants. Knowledge on essential nutrients, process of nutrients loss from the soil, nutrients requirements of plants and how to keep the nutrient balance in the soil for the vigor and growth of the plants are the key elements of nutrient management. Generally, nutrients are lost from the soil from the following processes :

- Removal of harvest from the land. In this case all nutrients are lost. Higher the yield, higher is the lost

- Volatilization due to burning and exposure to high temperature, in such case especially nitrogen will be lost
- Runoff can cause loss of nitrogen in the soil
- Leaching and erosion will make almost all nutrients loss from the soil

Nutrients can be added In the soil having nutrient deficiency. General process for adding nutrients in the soil are :

- All nutrients can be added in the soil by decomposition process of organic matter (OM)
- Nitrogen can be added in the soil by nitrogen fixation (planting nitrogen fixing plants)
- By weathering process mostly potassium and magnesium will be added in the soil
- Adding chemical fertilizer in the soil will add nitrogen, phosphorus and potassium in the soil
- Rain water and solid matter deposit will also help add nutrient in the soil

Organic matter : Organic matter (OM)is very important in soil fertility management. Organic matter is a left over materials of dead plants, animals and biota. These fresh organic matter disintegrate and decompose by soil organisms and convert into humus, which is also referred as organic soil matter. The humus further disintegrate by soil organism and nutrients are release in the soil, which the plants uptake. The rate of OM broken down depends on the climate and the soil organisms. The broken down of OM in warm and damp conditions will be faster than in cold and dry conditions. There should a balance in amount of OM and its rate of broken down. Generally, amount of OM added = or > that is broken down and there by lost. If the OM in soil is lost a lot by erosion or any other anthropogenic activities, it will be difficult to increase its level.

Soil Fertility : Soil fertility is important to increase the crop yield and enhance the level of productivity of land. Soil fertility is essential to increase the tolerance of plants against diseases and pests . Presence of organic matter (OM) in soil is the fundamental in maintaining soil fertility. The very first step in soil fertility management should be directed at maintaining organic

matter content in the soil. Importance of organic matter in soil fertility management are :

- Increase the soil fertility
- Improve the soil structure
- Increase capacity to retain nutrients and add nutrients in the soil
- Maintain soil moisture condition
- Help stimulates the growth of soil organisms, which, in turn, help make the nutrients from OM available to the plants
- Can bind Hydrogen 'ion' (H+) and prevent soil from forming acidic character

Soil fertility management can be done through adapting crop husbandry practices , crop management techniques, maintaining organic matter, adding organic manure / compost and using chemical fertilizer.

Crop husbandry practice contributes to the positive balance of organic natter in the soil. This is a practice how a farmer uses his/her land before and after the growing season to maintain optimum amounts of nutrients and moisture in the root zones of plants that plants need for growth and good production. Some of such practices to maintain soil fertility are : mulching, green manuring, intercropping, green fallow periods and agro-forestry. Green manuring and green fallow periods provide higher level of OM and greater availability of nutrients. Intercropping and agro-forestry ensure extensive root systems in the soil and better utilization of soil nutrients by different root systems. Mulching, intercropping and agro-forestry provide soil cover to prevent soil from evaporation and dehydration.

Adding compost and chemical fertilizer in the land are the most adopted practices by the farmers for maintaining soil fertility in Nepal. Composting is a good practice for maintaining soil fertility as this practice increases the infiltration capacity of soil, improves soil structure, supplies nutrients in the soil, increases soil organism, enhances the level of organic matter and water retention capacity of soil, maintains the soil temperature and creates soil aggregate stability.

If the soil is very poor application of prescribed limit of chemical fertilizer will be useful in soil fertility management. Nutrients can be directly added in the soil using chemical fertilizer. There are various types of chemical fertilizer with different applications. Chemical fertilizer restores the soil fertility quickly and makes the nutrient available to the plants as soon as the fertilizer dissolved in the soil.

Practice of adding chemical fertilizer is quicker than adding organic matter to maintain soil fertility of degraded soil, however adding chemical fertilizer alone in the soil having low level of organic matter is not sufficient to maintain soil fertility since the chemical fertilizer alone will not help improve soil structure and its capacity to retain nutrients and water . Chemical fertilizer increases soil acidity. Therefore, integrated approach of adding chemical fertilizer and crop husbandry practice for maintaining the level of organic matter in the soil is important in soil fertility management.

Unit 4. Legal Aspects

4.1 Land Tenure (Babu Ram Acharya : Land Tenure and Land Registration in Nepal. Stockholm, Sweden 14-19 June 2008; Dev Raj Paudyal : Pro-Poor Land Management System, A Study Considering Dynamic Aspect of Land Tenure in Nepal, Munich, Germany, October 8-13, 2006)

Introduction :

Land is the basis of human existence. It is the land we all get our food from, the material for cloth and shelter, build our landscape around us, our forests, contribution to a natural growth of people and the development of man's identity. Man being a part of ecosystem, he must protect the threat of sustainable natural outputs seriously which may arise by losses of variety of species, reduction in forests, soil erosion, acidification, deforestation and environmental pollution. This is reflected by reduced harvests, low farm income and a decrease in farmlands leading to enormous economic and social problems of rural population. The reasons behind these causes are mismanagement of land and its use including improper distribution pattern and traditional thinking on the concept of land and the natural resources.

Land Tenure Systems :

Land tenure can be defined as an arrangement of land holding, i.e. how land is held and used by individuals or institutions for economic opportunities (Henssen, 1995) i.e the right or manner of holding a landed property (Tuladhar, 2004). A main characteristic of land tenure is that it reflects a social relationship between man and land in both formal and informal environment.

The word "Land Tenure" is derived from the Latin "Tenere" meaning "to hold a tenant" is simple one who holds. Land tenure has to do with land-man-and the rights. It is the nature of legal estate in land such as freehold, leasehold, mortgage or occupancy.

There are many forms of rights over land in practice all over the world. In Nepal, land tenure is based on Hindu and Customary concepts. In Nepalese Land Administration history, the system of land tenure has evolved in various forms and phases. The state ownership was the traditional form of land tenure in Nepal. The land was belonged to the state and King was the head of the state. Later, six major forms of land tenures were recognized as Raikar, Birta, Jagir, Rakam, Kipat and Guthi land (Tuladhar,
2005). They were :

Raikar

The term "Raikar" is probably derived from the Sanskrit words Rajya (state) and Kara (tax), thereby denoting land on which the state levies taxes. This is a private land on which taxes are payable to the government and is listed in the official records.

Birta

The term "Birta" probably derived from the Sanskrit word "Britti" meaning livelihood. In other words, Birta means granted land to individuals to enable them to make living. The following Sanskrit lines appear generally in Brita grants as: Anybody who confiscates the land granted by him or by others shall in his next life be a worm living in human excrement for 60,000 years. Birta land had no absolute ownership rights. Birta land may be utilized according to the terms and conditions prescribed in the grant.The policy for abolition of Birta system and conversion of all Birta holdings into raikar has been declared since 1951 but it was functional only in 1959. The policy was given legislative effect in the form of Birta Abolition Act 1959.

Jagir

The term "Jagir" is of Persian origin and denotes the emergence of Jagir tenure to assign

Raikar land to government employees and functionaries. This practice was followed by the government until 1951. It was the policy of the government to pay the salaries of civil and military employees in the form of Jagir assignments as far as possible. The assignments were made until the death or termination of employment of the employee concerned. The Jagir system was finally abolished in 1951 after the downfall of Rana regime. All Jagir holdings then reverted to the state.

Rakam

This system was originated from the assignment of land as the remuneration for the performance of specific functions, mostly of a manual character. Rakam was temporarily assignment and lasted until the death or termination of service. Rakam lands has been assigned to carpenters, bricklayers, mail carriers, musicians

(Kusule), caretakers of religious places and similar categories of manual working. This system of Rakam land was abolished in 1955 and converted into Raikar lands.

Kipat

Kipat system is essentially a form of communal tenure and certain ethnic groups are permitted to own land. The most prominent groups are from Limbus, Bhote, Majhi and Tamangs. Kipat system was abolished in 1964 when land reform campaign was launched.

Guthi

The term Guthi is probably derived from Sanskrit word "Gosti" or council. Land assigned for charitable, religious or philanthropic institutions came under Guthi tenure. There are different forms of Guthi lands. Majority of cases come under state administration called "Rajguthi". Sometimes Guthi lands are privately operated but grants are registered in the official records called Darta Guthi, and those not registered and generally used for religious purpose are Duniya Guthi. Guthi land may also be owned by monasteries. There are different categories of Guthi land that still exist.

The distribution and access to land was not scientific in early days. Most of the customary land tenure(s) have been abolished since 1951. The present land tenure system is simple. The type of land tenure(s) are:

- Private land (Raikar) with absolute ownership: It means that land on which taxes are payable to the government and is listed in the official records This type of land can be hold by the owner himself or may lease or mortgaged.
- Public and Government: Public land belongs to the government but is used by the public or community where as Government land is handled by itself.
- Trust land or Guthi land: There are numerous types of Guthi land specifically Rajguthi,Nigiguti, Chutguthi, Guthi Tainati and Guthi Adhinastha.

Now only two types of land tenures such as Guthi and Raikar exist as an official recorded Land Tenure System in Nepal, which is termed as Formal Land Tenure System and another is Informal Land Tenure System which is referred as Public and Government lands . This type of land tenure system is neither officially recorded by the government nor recognized by the cadastral system of Nepal. This type of land tenure system is mostly found on urban and semi urban areas of Nepal. In remote areas also the informal land tenure system exists in Nepal. Government lands and public lands are occupied by landless people, conflict victims and bonded labors. Due to the political conflicts, some private lands are also occupied by conflict victims who are displaced from their natives.

Based on this definition the informal settlements, the types of informal settlement in government and public lands can be categorized into four Groups :

Slums: They are legal but overcrowded, under serviced settlements. They are normally found in the centre of the cities but are not uncommon to find them also where the land is rented, in the urban periphery. They are unplanned settlements, very old and not compliance with current planning and building regulations.

Informal Settlements: They are not landless people but occupying the government and
public lands. They are socially accepted but do not have the legal right.

Landless Settlements (Sukumbasi Basti): They are landless people occupying the government land, forestland, or public land. The land has been occupied illegally. They are unplanned and often unserviced. They can be found on marginal or environmentally hazardous lands, both in urban areas and remote area. Various high level committees have formed to solve the problems of such settlements.

Bonded labor Settlements (Kamaiya Basti): "Kamaiya" is the term for agricultural workers or tenants of farmland working on farm or in house as labor in the verbal or written agreement with landowner of Terai areas of Mid and Far Western Development Regions of Nepal.
− Kamaiya whose share of the crop is one third of the product of land
_ Kamaiya whose share of crops of the assigned land.
− Kamaiya receiving wages.
− Kamaiya receiving fixed annual food grains and other materials

Legal Base of Land Tenure :
It will be relevant to mention the purpose of land registration and its legal basis in Nepalese context. The most fundamental purpose of land registration in Nepal is to establish certainty of ownership, rights to land and collecting revenue (tax). Other important purposes are to facilitate the transfer of land and other land-related activities and to provide easy access to information about land. The legal instruments such as Land register (Moth), Restriction Register, Survey Field book, Parcel Map as well as the registration processes are the vital tools to reach these objectives. Stamp duty as well as registration fees are set when applications for transfers and mortgages are registered at the Land Revenue Offices. As indicated earlier, land related laws in Nepal
are based on old traditions and rules. The agrarian situation in early days was characterized by a landlord- tenant relationship. The tax records contained only the names of the landlords and not of the actual cultivators. In addition, most of the landlords were reluctant to provide receipts of rent payment. It has deprived

documentary evidence of their rights to the land cultivated by them. All land in Nepal is defined by land parcels as real property. A property may consist of the land and the fixtures. In short, structures that are attached to the property on a more permanent basis are fixtures according to law. The most common fixtures are trees and buildings. Real property owned by the state (government), local municipalities or any other public body (e.g. temple) is treated in the same way as property owned by a private individual. The property records are open to the government and the public. Any changes in the ownership and use can not be done without the consent of owner.

4.2 Water laws in Nepal (please refer Annex)

4.3 Soil and watershed Conservation Act, 1982 (please refer Annex)

4.4 Soil and Watershed Regulation, 1985 (please refer Annex)
4.5 Other legislation related with the protected areas (please refer annex)

Unit 5. Management Approach

5.1 Introduction (History) to the Watershed Management Approaches

It was the 3rd Five Year Plan (1965-1970), in which the watershed management was first apprehended in Nepal. An autonomous Bagmati Zone Afforestation Office was established under the guidance of Department of Forest, in which pilot demonstration programmes on watershed management were lunched in Trisuli, Panchkhal and Sunderjal Watershed. (**In the 4th Five Year Plan (1970-1975),** the Department of Soil and Water conservation (DSWC) was established to organize the soil conservation works systematically and institutionally, within Ministry of Forests in 1974
In the 5th Five Year Plan (1975-1980), Shivapuri watershed Area development Board (1976) was created, Nepal remote sensing centre (1979) established in DSCW, concepts of integrated watershed management introduced, Regional development concept in soil conservation and watershed management was introduced and 14 watershed management projects with the support from government and development partners were implemented in the four regions of the country. River control works in the watersheds were also continued from DSWC.

In the 6th Five Year Plan period (1980-1985), the initiation of Environment Impact Assessment of development project was first initiated by DSWC in Nepal

by running a Environment Impact Study Project. The name of DSWC was changed into DSCWM, river control works were transferred to Ministry of water resources and the name of Ministry was changed to Ministry of forest and soil conservation. The Soil conservation Act, 1982 and Regulation, 1985 came into effect. High level National resource Conservation Commission(NRCC) formed under MoFSC.

In the 7th Five Year Plan(1985-1990) period, DSCWM emphasized on integration of water resource, agriculure and forest development works to maintain a balanced environment through the conservation and improvement of natural resources. This was initiated by lunching several integrated watershed management projects in the country. Master Plan for the Forestry Sector considered the watershed management as a primary programme. People's participation and people's awareness programme in watershed management were envisaged.

The 8th Five Year Plan Period (1992-1997), was in fact a turning point in people's participation in watershed management. People participation guidelines with the provisions of formation of users groups and partnerships with NGOs and CBOs in watershed management was developed. DSCWM established its territorial offices in 35 districts. Conservation of churia hills, promotion of bio-engineering practices and conservation education in watershed management were focused.

In the 9th Five Year Plan Period (1997-2002), the Nepal Environment Policy and Action Plan –II (NEPAP) enunciated policies of involving local communities and civil society and promoting new technology in cropping pattern, agriculture and land use system in watershed management . The protection of churia hills considering the vulnerability to erosion and landslides of chure regions was emphasized. The 9th plan also recognized watershed management as as supporting other programmes in poverty reduction.

The 10th Five year Plan (2002-2007), was the continuation of activities of 9th plan regarding involvement of private sectors and civil society in improving the livelihoods of the rural poor and strengthening the institutional governance process. Participatory and integrated sub-watershed planning approach and networking of watershed management stakeholders were emphasized. The DSCWM expanded its territorial offices to 55 disstricts.

The 11th Three Year Interim Plan (2007-2010), emphasized the livelihoods improvement and poverty reduction of poor, dalits, disadvantaged groups, women

through the implementation of participatory and income generation activities in watershed management. The territorial office of DSCWM expanded to 56.

The approach paper of Three Year Interim plan (2010-2013), has focused on development of watershed management through the basin and landscape concepts. More focus has been given to livelihoods improvement, environment protection, income generation, participation and poverty reduction of poor, marginalized community, women and dalits.

5.2 Management Approach

5.2.1. Line agencies implementation/participatory-Decentralized approaches

Watershed Management is the management of all the natural resources available within the watershed. These resources are ; agriculture, forests, water, land , biodiversity etc. As mentioned earlier, watershed can not be managed in isolation. Watershed management implies management of all the resources in integration. For integrated way of managing watershed, one institution should take a strong role (lead agencies) for coordination and integration and other responsible agencies should act as line agencies and support the integrated programme by implementing their responsible activities in integration. In this approach, the development partners to support the programme directly works with the lead agencies. The lead agency coordinates with other responsible line agencies for coordination, programme design, planning and integration . In the case of integrated watershed management project/programme, general practice is that the DSCWM acts as a lead agencies where as the Department of Forests, Department of Agriculture, Department of Irrigation or Water resources and other responsible agencies act as line agencies to support the integrated programme of watershed. This approach was adopted by DSCWM for more than one decades of its implementation.

The above mentioned line agencies approaches were effective only in implementing the sectoral line agencies programme in the watershed. Actual integration of programme and effective coordination among line agencies were lacked which resulted in the unsustainable impacts of project and programme. People's participation in the programme were also not effective. Niether the government nor the donors could address the watershed and people's problems. It was later realized that the DSCWM should adopt the participatory and decentralized approach in watershed management to address the local development need by mobilizing local resources including local participation and act collectively by communities in order to make a difference in their lifestyle and

living standards. It was also envisaged that the community participatory approach to watershed management could network, coordinate and combine outside resources. Such approach could bring sustainability and self reliance as a result of effective participation and local resource mobilization.

Based on these facts, The Eighth Five Year Plan (1992 - 1997), envisaged a policy of implementation of watershed management project and programmes through the mobilization of users group and their participation. In fact, the Eighth Plan was a turning point in the history of people's participation in watershed management. The department brought out implementation strategy and people participation guideline, which provisioned for formation of Users groups and their involvement in planning, implementation and decision making. Recently, the department is implementing all the watershed management programmes in the districts through participatory approach forming and mobilizing users groups/ users committee.

In the past, the management approaxch taken by the department was truly based on project approach with support from various donors. Three distinct project approaches were adopted They were :

1. Single Umbrella approach : In this approach, department adopted one roof with multi-disciplinary services resource inputs

2. Multi Umbrella approach : This was the approach where sevaral line agencies were coordinated and facilitated with resources taking the lead role by the department.

3. Integrated Rural Development Approach : In this approach, focus was on integrated rural development of the district with main emphasis on conservation and local development.

5.2.2. Sectoral/Integrated (Holistic) Approaches

Sectoral approach / Sectorwise approach (SWAp) :

the **Sectoral approach** is synonymous to project approach (***also refer project approach in this note***) in which formulation and implementation of the programmes that focus on specific sector or subsector and whose components or sub-projects are also tied together in a coherent and coordinated fashion. In watershed management, the sectoral approach does not yield promising results as the watershed management is the integrated management of all the natural resources available within the watershed through coherent and coordinated environment with the sectoral line agencies for the protection of the environment and livelihoods improvements of the poor and disadvantaged communities. The sectoral approach

to watershed management could be more focused to certain specific area. Watershed management for the development of water resources or it could be conservation of bio-diversity or agricultural production etc. In a broad sense, the sectoral approach to watershed management have specific geographical area, goal, objectives and programme components. Sectoral approach is a piece meal approach and does not address all the dimensions of watershed degradation problem.

The sectoral approach can also be discussed in terms **sectorwise approach (SWAp).** The SWAp is where all significant sector investments are channeled towards the same objectives and follow a consistent strategy guided by a consolidated investment plan. Main prerequisite for the SWAp is to have a robust and harmonized national policy framework and strategy, plan and programme for the sector. The SWAp allows funding agencies to contribute to a national programme of development instead of piecemeal project specific development initiative. Funding modalities under SWAp is basket funding deliver to sector or programme from donors, national budgets and users contribution. It also includes the possibility of funding activities through NGOs and private sectors. The basket funds will be managed by the government and a lead donor using project fund modalities.

The main advantages of introducing SWAp are :

- increases donor or funding agencies coordination and reduces the likelihood of overlapping and duplication of programmes.
- enhances the government capacity to ensure uniform practices
- reduces the administrative and financial burdens of dealing with a number of donors applying different policies and administrative practices.
    - establish national level harmonized strategy and common approaches for a given sector
    - efficient use of limited funds from donors, national budgets and user contributions to sector development.

• built participatory approach to planning and follow-up activities
• cost-effectiveness and sustainability of services provided
• improve monitoring, transparency and reporting systems.

The integrated (holistic approach) to watershed management (Refer to Integrated watershed management section of the note)

5.2.3. Conservation in Individual Farm/Community Lands

DSCWM brought a practice of doing soil conservation work in individual farm. The programmes for individual farm for both improve productivity of land and income generation are terrace improvement, agro-forestry, conservation farming, grass planting, planting fruit crops etc. These programmes are encouraged by the government by providing some subsidy to the farmers those who are interest to carry out the programmes in the individual farm. Some concepts of Model farmer are also developed to support the conservation in individual farm **(*also refer model farmer in this note*)**

After the concept of Users group, DSCWM envisaged a concept of community involvement in watershed management. Communities were organized in order to ensure people's participation in watershed management. Community Development Groups (CDGs) at the village clusters was constituted to implement the activities of users groups. The groups were formed based on the number of household of closely clustered household of a village sharing common interests on community resources in order to implement soil conservation and watershed management activities. CDGs representing households of cluster had been the main vehicle to implement the activities. District Soil Conservation Office (DSCO), in collaboration with other stakeholders, identifies primary users through field-level consultation. Users' problem, priority areas and programs are identified. Members from the 'primary users group' are nominated from each beneficiary household and form an action committee with a chairperson, vice chairperson, secretary, treasurer, and members. The committee is called a Community Develoment Committee (CDC). All others users are the general members of the committee. Community Development Committee (CDC) is a elected body from primary users groups or CDGs ,which took responsibility to plan and co-ordinate CDGs in order to mobilize both human and watershed resources. Various groups of local people including from diverse castes, genders, poor economic classes and ethnic groups were encouraged to be members in CDGs and CDCs had shown keen interests to participate and sharing labor as well as monetary costs even with a nominal motivation from district/ project offices. The CDC, which later was renamed as Community Development Conservation Committee (CDCC) in every village. Each CDG had given fixed budget depending on the number of active member-household (who paid the regular membership fee), distance from road head and the number of years since establishment. The CDG were informed about their budget, programs, financial support. The budget and programs were channeled through the District Soil Conservation Office (DSCO) to the CDG operated bank account. Technical support from DSCO staff was free of charge and everything else was negotiable. The idea of forming CDG and providing a fixed budget was to develop true feeling of ownership. CDG used to use its budget to implement any of the many possible activities according to soil conservation and watershed

management policy and CDG's plan. More CDG contribution, the more activities they implemented from the fixed budget.

Within each CDC/CDCC, different CDGs were formed. CDGs belonged to water user group, forest groups , mother group, disadvantaged groups, income generation group etc. Each CDG was managed by its own executive committee. Thus CDC/CDCC worked as a multipurpose CDGs groups serving a larger common interests. The concept of CDG contributed for:

- active participation in watershed management
- participatory planning, implementation and self monitoring
- capacity building of CDGs members
- introduced small-scale income generating activities
- felt the ownership of program
- facilitated bottom-up planning approach
- encouraged social inclusion
- empowered and focused different ethnic, disadvantage poor, vulnerable groups and gender
- adopted the concept of community based watershed management practices
- enhanced the leadership qualities and mobilized in participating local poor people in watershed management.

5.2.4. Basin/Watershed/Sub-watershed/Micro-watershed/Political Unit

River Basin, Watershed, Sub-watershed, Micro-watershed, catchments, drainage basin are interchangeable and used commonly as per management objectives. However, a watershed is differentiates from a river basin in that a river basin, whose main stream leads to the sea, may encompass hundreds of watersheds and many other types of land formation (Sheng, 1990)

Watershed is an ideal natural unit over which hydrological processes are integrated and for which a water balance may be constructed to show the disposal of precipitation into a number of subsequent forms i.e. interception, soil moisture and ground storages, evapo-transpiration and run-off. Also, watershed approach is logical for evaluating the biophysical linkages of upland and downstream activities, this approach is holistic and evironmental impacts can readily be evaluated (Eastern and Brooks, 1985).

Recently, DSCWM is trying to focus watershed management into a river basin management approach. This will be shift from micro level (sub-watershed) to

macro level (basin level) where DSCWM will work for environment sustainability. The river basin management approach will be integrated and its purpose will be to serve the people and manage the environment sustainably through protection, rehabilitation, reclamation of the basin. In the basin approach, major focus will be given to the sustainable management of environment rather than utilization and management of the basin as a whole. The rehabilitation plans of Koshi, Gandaki and Karnali basins for environment conservation are going to prepare by DSCWM. The institutional structure and the functions of Basin management at center and local levels will be developed by DSCWM during the course of preparation of the plan .

5.2.5. Model farmer/Group Approach

Soil Conservation and watershed programs place high priority on farmers. National policy on watershed management has emphasized to implement soil conservation activities in such away that the activities contribute both conservation and generate quick income.

The national soil conservation policy also strives to increase productivity through conservation farming and development activities. the adoption of more effective and integrated community owned natural resource development activities is another important focus.

Development projects implemented by Department of Soil Conservation and Watershed Management have trained local farmers and thier users' groups on appropriate land use management at farmers field level. The projects have generated many local level innovative farmers as model farmers, who have significantly contributed for conservation and utilization of natural resources .
Through the initiation of projects, many innovative farmers have developed their farms as model farms, which have served as farmers' field laboratory and demonstration sites to other neighbor farmers. In most of the cases, the model farmers have developed their farms for crop diversification / permaculture , income generating activities, agro-forestry . These model farms as developed by model farmers have generated demonstrative effects to other visiting neighbor farmers. Model farmers have improved their livelihoods through accruing economic benefits by changing their marginal land into productive and conservation farms.

The model farmers in the project areas are those farmers who have shown following characteristics :

- innovative
- demonstrative
- motivate
- initiative
- interactive
- participatory
- consultative
- able to mobilize local skills and resources
- organize self-help programs
- ensure co-operative
- able to take ownership
- able to resolve conflicts
- capacity to mobilize neighbor farmers
- able to work for social welfare
- access to development agencies

User Group/ Conservation Committee.

The concept of Users group and conservation committee to implement and coordinate the watershed management came into practice, when the department launched its guidelines for people's participation in soil conservation and watershed management in 1993. During that period, government brought a mandatory policy to implement any program/project worth up to one million, through the participation and mobilization of user groups.

Process of forming users group in watershed management :

- Identify priority watershed/sub-watershed, where watershed management interventions are to be carried out
- Visit the prioritize watershed/sub-watershed, collect bio-physical and other necessary information including beneficiaries households
- Conduct several meetings (as and when needed) with the locals and beneficiaries households.
- Brief and discuss the plan, objectives, programs, problems and interact with local people and beneficiaries
- Make a list of users /beneficiaries and classify the households into three categories

1. First Category: Households using natural resources of watershed and are directly affected from resource depletion.

2. Second Category : Household indirectly using the natural resource of watershed but not affected by resource depletion.

3. Third Category : Household indirectly using the natural resources of watershed and will be directly affected by resource depletion.

- Form Users group from the above listings. Users group members are nominated from each beneficiaries household.
- Notify the DDC, VDC, DSCO, CDO about the formation of Users group and registered them in CDO office with a written constitution, if necessary
- Negotiation : Negotiate with users for planning, implementation of program, cost estimate, benefit sharing, maintenance, monitoring, follow-up through holding meetings with users.
- Agreement : Help Users group committee for the preparation of program implementation , monitoring , maintenance, budget flow plans and time schedule and make an agreement between users and DSCO.
- Implementation : Users group implement the plan as agreed where as DSCO office provides technical and equipment supports to carry-out the activities. Users group make necessary arrangement for manpower.
- Maintenance and benefit sharing : This is to be done by users groups with due considerations of the project implementation experiences and managerial experiences of the users.
- Capacity building : Capacity building of Users group will also be done by the DSCO by providing appropriate trainings as needed.

5.2.6. Project/Programme Approach

Programme approach :

Programme approach is a process that helps governments to formulate national priority development objectives and to realize these objectives through corresponding national programmes formulated and implemented in a coherent, coordinated and participatory manner to ensure sustainability. The critical principle that the approach should always support. national programmes or national programme frameworks or policy. Programme approach is an integrated national

multisectoral programmes, which are normally and have a variety of funding partners. This is a shift from an exclusive focus on project inputs and activities towards broader policy concerns and development impact. It is an appropriate mechanism for building strong development partnerships through broad national ownership, coordination and co-financing.

Advantages of Programme approach :

- addresses the excessive compartmentalization and weak national ownership of international cooperation and activities.
- prefers to tackle only one development problem or objective but address it in all its dimensions.
- support national programmes and policies
- promotes potential synergy between national ownership, partnership and coordination among sectoral ministries and other stakeholders
- develops new channels in collaboration to work and implement programmes more closely with decentralized governments, civil society, communities, NGOs, academics and the private sector,
- promotes greater sustainability in programme implementation and development cooperation
- promotes participation of the entire society (central and local governments, communities, non-governmental organizations (NGOs), universities and private consulting groups).
- overcomes recurrent difficulty in capacity-building by addressing the needs of all national partners.
- brings national ownership, strategic and holistic thinking, a multi-sectoral focus, coordination and participation
- brings flexibility, connectivity and enhances national as well as development partnerships ownership in the programme. and among the cooperation
- performs joint and common monitoring and evaluation of the programme and creates national accountability
- Programmes are generally easier and less costly to evaluate
- creates more effective, efficient and flexibility in budgeting and budget revisions.
- more conducive to co-financing and resource mobilization from funding partners
- Not a donor driven
- reduces management cost of the government and funding agencies

Disadvantages of programme approach :

- programmes implementation requires greater capacities from executing agencies in the areas of management, negotiation, coordination, planning, outreach and data-gathering and dissemination.
- requires strong strategic thinking, coordination and considerable time, effort and capacity
- involves complex procedures and accounting rules
- requires relatively more time and tends to be more difficult for designing, coordination and implementing the programmes and finishing the formalities of government and donor agencies
- supports the development of national programmes only when these are back by strong political will, meaningful government resources, and capacities
- It is inapplicable in the country, owing to a very segmented administration and to the lack of government trust in planning as a tool for development and low sense of national ownership
- Difficult in countries where a bureaucratic mechanism and the long-term strategy and policy culture are not developed
- Difficult where the national administration is highly sectoral in culture and structure, e.g., when there is no government body strong enough to coordinate line ministries.

Project approach :

Project approach is a process to formulate and implement the programmes that focus on specific sectors or subsectors and whose components or sub-projects are also tied together in a coherent, coordinated fashion. In this approach, projects are designed and managed independently and are placed under a single programme to achieve greater simplicity and flexibility in the allocation of funds, implementation, monitoring and evaluation. Projects are designed and implement without any linkages among line agencies and concerned stakeholders at central and district levels. Project approach merely support the national programme and policies. Project approach is more segmented, focused on particular programme and set objectives and time line. Programmes under

the project approach have to stand on its own without strong coordination, integration, collaboration and participation of the entire society (central and local governments, communities, non-governmental organizations (NGOs), universities and private consulting groups) in programme designing and implementation. It does not develop new channels in collaboration to work and implement programmes more closely with decentralized governments, civil society, communities, NGOs, academics and the private sector. It ties up with one or two government institutions and implement the programme directly.

Advantages of Project approach :

- concentrates effort on a specific task, a precise geographical area or a clear set of beneficiaries
- projects manage independently and place under a single programme to achieve greater simplicity and flexibility in the allocation of funds
- clear vision, goal, objective and mile stone
- able to clearly track progress
- requires relatively less time to design a project
- Programme implementation and coordination do not require greater capacities from executing agencies in the areas of management, negotiation, coordination, planning, outreach and data-gathering and dissemination.
- Does not require strong strategic thinking, coordination and considerable time, effort and capacity
- programmes are generally easier and less costly to evaluate
- Easy to design, implement and coordinate the activities
- Projects manage by executing agency and development partner
- Monitoring/evaluation through tripartite review meetings, bilateral mid-term reviews and independent evaluations.
- Not require co-financing and heavy resource mobilization
- unlikely to miss something major by having a specific and consolidated plan
- not require strong political will, meaningful government resources, and capacities
- easy to apply in the country with segmented administration and low sense of national ownership
- more appropriate for the country where a bureaucratic mechanism and the long-term strategy and policy culture are not developed

- appropriate for the country when there is no government body strong enough to coordinate line ministries.

Disadvantages of Project approach :

- Does not address all the dimensions of development programmes
- Less supportive to national programmes, policies and priorities
- Lacks synergy between national ownership, accountability, partnership and coordination among sectoral ministries and other stakeholders
- sustainability of the project's programmes is questionable
- weak participation of the central and local governments, communities, non-governmental organizations (NGOs), universities and private institutions
- does not address the needs of all national partners.

- lacks strategic and holistic thinking, a multi-sectoral focus, coordination and participation
- lack of full integration of programme components

- Non-conducive to co-financing and resource mobilization from funding partners
- donor driven approach to development
- increase management cost of the government and funding agencies

5.3 Development Strategies to Enhance Local management Capacity

5.3.1. Ownership building

Ownership building is a means by which individuals or institutions have legal rights of possession or control over property or regime (any kind) or it is a felling of own responsibility and entrust other in the management and preservation of development endeavors. It is a complex or abstract concept in the development process. Rights of possession or control over property can be explained in many ways. For instance, the state property has state ownership, which can also be used by individual or group temporarily by furnishing the legal procedures but the ownership always rests on the state. Likewise, private property has private ownership (ex: private forests) and the ownership of common property lies on the commons or groups (ex: forests, watershed). No definite owners and ownership

will be there on non property or open access (ex : fishery in the open river). " Everybody's property is nobody's property".

There are many weakness in the ownership building of an individual, groups/ commons or institutions . Lack of leadership, ignoring the importance of beneficiaries or users participation, lack of information sharing and transformation, non –transparency, non involvement of sub-ordinate staff and stakeholders at all the phases of project cycle etc. are some of the examples of the weakness in ownership building. There are some elements , which will help enhance the ownership building of the individuals or groups or commons or institutions. They are :

- Build confidence in the individuals/groups/commons/institutions
- There should be proper legal institutional environment
- Let the ownership status be clearly established and understood to the individuals/groups/commons/institutions
- There should be proper legal institutional environment
- Create voluntary contribution or participation mechanism in the work
- Let them fully understand the importance of the property, its management and preservation
- Secure their future without interfering from outsiders
- Generate benefits to meet their own needs
- Build mutually entrust environment with each other and over their responsibilities
- Empower the individuals/groups/commons/institutions

5.3.2 in - situ Institution

In-situ Institutions are non government, autonomous and independent institutions to plan, participate, facilitate and act as connecting point to bridge the gaps between local people, government, donors and others. These institutions sometime act as pressure groups to the government, donors and other institutions. These institutions are at grass root, regional and national levels. There were no in-situ institutions until the 6/7th Five Year plan of the government, which came into existence since the start of the 8th Five Year plan of the government. Since this plan period there have been increasing trend of establishing such institutions at all

districts. Most of these institutions are engaged in programming, planning, implementation, evaluation and monitoring and social inclusion in the development activities. Increasing partnership and collaboration of such institutions with government , donors and INGOs are existed. In-situ institutions are facilitated by government, donors and other non-government institutions. Government has introduced service providers guideline (forestry sector) in order to make uniformity in the function, roles and responsibilities and transparency of these institutions. Government, donors and INGOs also provide capacity development programmes to such institutions to strengthen their capacity in mobilizing local resources, decision making process, fund management, participatory learning and social inclusion and sensitizing poor, dalits, disadvantaged groups and women of the communities in local development activities. Many in-situ institutions have established network and federation at VDC, DDC and national levels. Examples of some of the grass root level in-situ institutions are : CFUGs, CDGs, CBOs, CSOs, self help groups and local NGOs . Some of the functions of the in-situ institutions are :

- Motivate stakeholders, communities, UGs, and beneficiaries in mobilizing local resources, fund flow, management, planning, implementation, monitoring and participation
- Facilitate/motivate poor, dalits, disadvantaged groups, women etc. at all phases of programme/ project planning through the social inclusion
- Empower and facilitate capacity development programme to the poor people, disadvantaged groups and women
- Facilitate group formation, group work and mobilization of local resources
- Conduct income generation, awareness generation, environment protection, livelihoods improvement, health and education related programme to the local poor people, disadvantaged groups and women
- Facilitate and play supportive roles at village level planning, community level planning and implementation
- Mobilize and manage necessary resources require for the local development

Some of the weakness of the in-situ institutions are :

- Mis-management of funds and resources
- Donors driven/and high dependency on government /donors/INGOs
- Lack activities/resources/networking

- Selfness attitudes, egos, non transparency and non informative
- Weak leadership and institutional arrangement
- Highly politicized

5.3.3 Networking and Linkages :

Networking and Linkages are broadly defined as a group of people and organization, which come together to share information and develop cooperation on one or many sets of issues in order to make progress towards achieving common goal. In other word, it is an interconnected group or system of organization, institutions or individuals working together for a set of common goal and objective to manage their resources. Networking and linkages develop contacts or exchange of information and services among individual, groups or institutions in an formal or informal ways. It is a powerful and applied tools for communities, NGOs and institutions to share knowledge, communication and services. Networking and linkages is also referred as knowledge management. There are many networks such as NGOs network, grass root organization networks, environment forum, indigenous people networks, multiple stakeholders network, national/sub-national/regional/ international networks , CFUG network, watershed management network etc.

Objectives : The main objectives of the Networking and Linkages are :

- Information sharing and communication
- Capacity building and knowledge management
- Co-ordination and integration of activities
- Develop advocacy with the concerned parties for its own agenda
- Problem solving /conflict management
- Help protect the right of ownership (right over the NRM)

Advantages :

- Advocate for its own agenda and build the synergies associated with cooperation
- Empower the stakeholders and local communities through capacity building and knowledge sharing

- Raise voice and dialogue with government or advocacy
- Generate pressure positively and resolve conflicts
- Seek and share advice /ideas to the concerned institutions/authorities
- Build relationship and trust among stakeholders
- Increase mutual understanding
- Create non-violent solutions to problems and conflicts

Many networks are seen continually working for several years and have addressed the many issues or shared knowledge for a common cause. Some are dissolved when the issue are resolved. Some are not functioning well because of the week institutional arrangement, leadership and resource constraint. The success of networks depends on :

- Clear vision and mission and robust management and institutional structure
- Strong leadership
- Effective communication
- Adequate resources
- Openness , inclusiveness and transparency
- Strong alignment with support organizations
- High quality and level of advocacy

Unit 6. Soil Conservation Program and Activities

In order to implement soil conservation and watershed management program and activities in line with the policy, strategies and objectives thus formulated, the department has developed and incorporated number of programs as follows :

6.1 Land use Planning :

Land use plans are the basis for the rational utilization and management of watershed resources. These plans are prepared by using scientifically analysed land capability. Three types of activities are carried out under this program.

a. Watershed management Planning
b. Sub-watershed management Planning
c. Technical service for land use and development

6.2 Productivity Conservation :

These programs are designed to restore and improve the productivity of private and community lands. Under this program, the main activities carry out are mostly biological measures. They are:

a) On-farm conservation practices
b) Plantation of tree, grass and establishment of green/shelter belt
c) Agro-forestry, nursery operation and conservation plantation.

6.3 Natural hazard prevention :

These programs are intended to help reduce damage to life, property and valuable natural resources caused by different types of natural hazards. Major activities under this category include :

a) Gully and landslide treatment, torrent control, stream bank protection and degraded land rehabilitation
b) Construction of check dams, retaining walls, diversion channels, grass sowing and tree planting

6.4 Infra-structure protection :

These programs include those measures, which protect and stabilize basic development infra-structures such as reservoirs, irrigation system, roads and others with the aim of improving the economic life of the infra-structures. Bio-engineering measures are usually used for slope stabilization, roadside erosion control ,trail improvement, irrigation canal improvement.

6.5 Conservation extension/education :

In order to combat conservation problems, the department has introduced conservation extension and education as well as regulatory preventive and rehabilitative measures. This is because programs play a key role in mobilizing people and in generating conservation awareness. Under this program the main activities include :

a) Conservation demonstration
b) Extension education
c) training and study tours
d) Support to community development groups

e) Strengthening and institutionalisation process
f) Exhibitions,competitions and conservation technologies transfer

6.6 Income generating activities :

Main purpose of this program is to raise the economic status and livelihoods of the local community by introducing various income generating activities in the private and community lands. These include adoption of various forms of agro-forestry practices, planting fruit trees, coffee and improved variety of grass on marginal lands own by individual farmers and community.

Unit 7. Theory and Practical Watershed Management Planning

7.1 Integrated Watershed management Planning

Planning is a long term decision for the future consisting of cluster of programs of what a organization or country wants to achieve over a period of time. Planning is also an assessment and spatial scheduling of work to fulfill objectives. Generally, planning is approached at country level, which is also termed as national level planning. Planning is also be done at regional and corporate /organization level.

Integrated watershed management planning is a process of formulating and carrying out course of action in a watershed to achieve resource objectives taking into consideration of social, economic, institutional and bio-physical factors operating within a watershed

For an integrated watershed management, three levels planning have been identified by department of soil conservation and watershed management. They are :

- Reconnaissance level planning
- Semi-detail level planning
- Detail level planning

Reconnaissance level planning : This is a very general or board planning. various possibilities and priorities are determined by acquiring general and qualitative information. This is done at national/regional levels for the period of 10 to 25 years. This level of planning is a kind of project proposal.

Semi-detailed level planning : This is some how specific. In this planning, some semi-quantitative and semi-qualitative information of district or watershed are collected. In this planning, project fisibility and prioritization of district or watershed are made. Planning is usually done for 5 to 10 years.

Detail level planning : In this planning process, very specific information both qualitative and quantitative are collected. Based on the detail information, watershed/sub-watershed is prioritize. Possibility of project examined and Project formulation will also be done at this level for the period of 1 to 5 years.

Basic steps of watershed planning process :

- identify problems
- Recognition of needs
- Establish objectives
- data and information collwction
- analysis and review the data and information
- plan formulation
- plan implementation
- monitoring and evaluation

(why integration is necessary in watershed management and approach of integrated watershed management are discussed on Unit 1)

7. 2 Watershed information collection (Socio-economic, climatic, Agro-climatic zone, geological, land use, soil, demographic, slope, landform, land capability).

Before collecting information on watershed, it is necessary to ask where we want to go ? and what we want to achieve ? After having these questions in mind we need to set objectives. Objectives may be of two types :

1. General
2. Specific

General objective : This will contain very general statement such as -- To increase the productive of watershed through retarding the rate of degradation of watershed resources.

Specific objectives : It contains very specific statements, for example :

1. To conserve soil or water or forest
2. To improve water yield
3. To make local people aware of watershed
4. To enhance socio-economic status of local people

After setting objectives, we need to collect information and data of watershed to match and in line with given objectives. In other words, the objectives reflect what kind of information and data we need to collect. In collecting data and information following questions should be kept in mind :

1. Where is the area ?
2. What do we know ?
3. What information or data need to be collected ?
4. How information or data is collected ?
5. How reliable is information or data collected ?
6. Is there any gaps in information or data ?
7. data or information related to what aspects ?

Whatever data we collect they should be problem oriented. For the preparation of a sound watershed management, we need to collect following data or information of focused watershed :

1. Physiographic data : this includes location, elevation, area, soil, aspects, geology, landforms, land capability, slopes, erosion potential, watershed condition.
2. Bio-physical data : this includes forest types, use and condition, agriculture and cropping pattern, crop yield, livestock, bio-diversity
3. Land use data: area of forest land, agriculture land, barren land, range/grazing land, waste land, water bodies etc.
4. Climatic/hydrological data : rainfall, temperature, humidity, snow, wind, evapo-transpiration, floods sediments stream flow, drainage pattern etc.
5. Socio-economic data : population, average income, source of income, occupation, employment opportunities, sex ratio, age structure, rate of population growth, migration, literacy, fertility and mortality rates, health, community's structure, institutions, social behavior, family pattern, religious, culture etc.

6. Economic and market factors : land tenure pattern, marketing, pattern of cultivation, farming practices, labor, transport system, infrastructures etc.
7. Management related data : watershed problem, environmental problem, land management problem, shifting cultivation, forest destruction, shortage of forest products, fire, overgrazing, uncontrolled mining and quarrying, technical problems etc.

7.4 Sub-watershed prioritization

Why Prioritization ?

Generally, a district have several watersheds of various shapes and sizes as seen in the topographical and drainage maps. On the other hand there are limited resources available to address soil conservation and watershed management issues. Watershed management activities cannot be carried out in all the sub-watersheds or micro-watersheds at once or in a given time period due to constraints of financial and human resources. Therefore, efficient utilization of the available resources require the prioritization of sib-watershed and selection of programs and activities to be undertaken.

Program activities scattered throughout the district at a time will have resource constraints and have no significant hydrological benefit as well as ecological and economic advantages. Therefore, it is desired that planning, programming and implementation should proceed in priority sub-watersheds so as to gain intensified action in short time-frame. In accordance with this approach, the sub-watersheds in a district should be ranked and prioritized on the basis of erosion potentials and people's pressure on the lands.

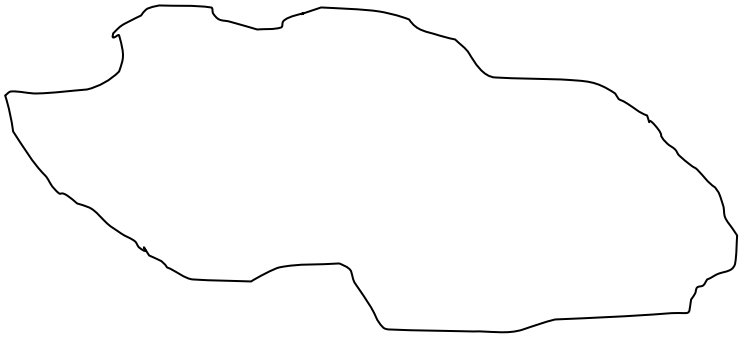
The Process of Prioritization :

For prioritization of Sub-watershed or Micro-watershed, it is imperative to get the information on bio-physical and population characteristics of the Sub-watershed (SW) or Micro-watershed.

Bio-physical Characteristics :

Step 1. Get a 1: 125,000 scale district map and delineate the sub-watersheds tentatively. Get a 1: 50,000 scale topographical map (LRMP, 1984) use this map to verify and confirm the SWs boundaries. The delineation of SWs is carried out to cover the area of 15- 25 Sq,Km. The SW should cover the ridge to the valley floor, if the area is toolarge, it should be longitudinally divided

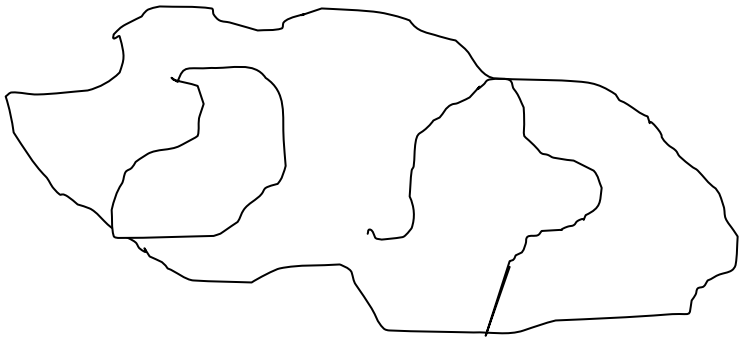
along the sream course as one of the boundaries.In this way base map of SWs is prepared on transparent sheet. Area of every SW is measured.



Example of a base map of a sub-watershed 'A'

Step 2. Preparation of Land Use Erosion Potential (LUEP) map

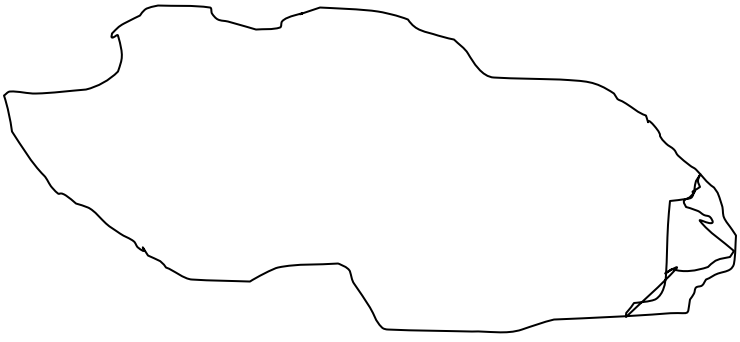
Get a land utilization map of 1:50,000 Scale (LRMP,1984), which gives the information on the erosion potential for different land uses broadly classified into High (H), Moderate (M), and Low (L) erosion potential areas depending upon agriculture land and forest crown density. Super impose the base map over the land utilization map at exact place and location as delineated SW. Give the alphabatical symbols like H or M or L to indicate high, moderate and low erosion potentials as indicated in the legend. In this way, Landuse Erosion Potential Map (LUEP) is prepared.



Example of Landuse Erosion Potetial Map (LUEP

Step 3. Preparation of Land System Erosion Potential (LSEP) Map

Similarly, get a Land System Map of 1 : 50,000 scale. Super impose the base map over the Land System Map at exact location and place as delineated SW. Mark high, moderate and low erosion potential areas in the base map with alphabetical symbols, h or m or l as given in the legend of the map.



Example of Land System Erosion Potential Map (LSEP)

Step 4. Preparation of Erosion Potential Composite (EPC) Map

EPC map is prepared by overlaying LUEP map on LSEP map. Common area overlapped by these two maps is traced out or marked on the third sheet. These overlapped areas are given double alphabet symbols taken from LUEP and LSEP. The symbols always started from the LUEP map. For Example,when LUEP is M and LSEP is l, then the symbol given in the EPC map is Ml. The double alphabet symbols of the EPC map are converted into single alphabet to indicate very high, high, moderate low and very low erosion potentials. This will be done using following conversion table

Double alphabet symbol of (LULSEP)	Single alphabet symbol of (LULSEP)
Hh	Veryhigh(H)
Hm,Mh	High (h)
Hl,Mm,Lh	Moderate (M)
Lm,Ml	Low (L)
LI	Very low (l)

Step 5. Calculation of erosion potential areas

The composite map (EPC of step 4.) and base map of sub-watershed (Step 1) are overllaid on each other. The very high, high, moderate low and very low LULSEP areas for each sub-watersheds are calculated with the helpn of planimeter or dot grid.

Step 6. Estimation of Landuse Land System Erosion Potential value (LULSEPV)

Very high, high, moderate low and very low LULSEP areas are given 8, 6,4,2,1 numerical values to compare erosion potential of sub-watershed quantitatively. LULSEPV is calculated using the following formula :
LULSEPV = (Very high area × 8 + high area × 6 + moderate area × 4 + low area × 2 + very low area × 1) ÷ Total Area of the sub-watershed . The value of LULSEPV can also be identified from the Table (Attached).
Step 7. Estimation of sub-watershed bio-physical value (SWSBPV)

SWSBPV = (LULSEPV -1) × 60 / (LULSEPV, highest -1)
The value of SWSBPV can also be identified from the Table (attached)

Step 8. Population Characteristics

Population density carries 40% weight in finalizing the sub-watershed prioritisation.

Estimation of Sub-watershed Population Density Numerical Value (SWSPDNV). Following formula are being used to calculate SWSPDNV

1. Numerical value when the population density of the SW is less than the average population density of the district :

SWSPDNV = (PD / APD) × 20 where as ,

PD = Population density of the sub-watershed
APD = Average population density of the district.

PD is calculated as = Total population of the district / District area.
For the calculation PD, delineate the VDCs that come within the watershed and calculate their areas by overlaying district map on sub-watershed map. Take the VDCs wise population density using CBC data and DDC profile by dividing population of VDC by its area. Calculate the average population density of VDCs. Taking sub-watershed area as 100 % calculate the percent area covered by VDCs. Then the average population density of the sub watershed is estimated using weighted average method.

2. when the population density of the sub-watershed is higher than the average population density of the district :

SWSPDNV = (PD - APD) / (HPD - APD) × 20 + 20 where as PD = Population density of the sub-watershed and HPD = Highest population density of the sub-watershed in the district.
APD = Average population density of the district. This can also be calculated using the Table (Attached)

Combining Bio-physical and population Characteristics to prioritize sub-watershed :

Estimation of Sub-watershed priority Cumulative Value (SWSPCV)

For this, the formula used is **SWSPCV** = SWSBPV + SWSPDNV this can be computed using Table (attached)

Priority Ranking :

The sub-watershed priority ranking is done based on the SWSPCV. The values are arranged in descending order for the prioritizing ranking. The priority is given to the sub-watershed with higher SWSPCV. The priority ranking table is given in Table (attached).

Other subjective Judgments in prioritizing Sub-watershed are :

1. Accessibility of the sub-watershed
2. Local people / community willing to participate and feel ownership
3. Availability of local resources
4. Scale of poverty
5. Proximity of government institutions and banks
6. Existence of local institutions like NGOs, CBOs etc.

7.6 Evaluation and monitoring of the watershed management program

Evaluation and monitoring is a part and parcel of the whole project or program cycle. Evaluation and monitoring system must provide data regularly and systematically, so that it may be consistently applied to the management of project/program activities.

Evaluation and monitoring of watershed management program is one management tool, that help to improve the process of watershed management program. This is also a management tool to increase efficiency and effectiveness of the program. This management tool increase awareness and understanding of various factors,

which effect them and there by increase their control over the development of watershed management process.

Evaluation and monitoring of watershed management program is a process within a system, which allow watershed beneficiaries to continuously share in assessing their own progress periodically, evaluate themselves to learn from past mistakes

Evaluation of watershed management program is a systematic analysis of program by management to enable them to adjust, redefine objective and policy, reorganize institutional arrangement, or redeploy resources as necessary.

Evaluation is the critical analysis of the results and effectiveness of a watershed management program or project. It aims at identifying the effect and impact of watershed management program or project.

Evaluation answers the questions such as :

1. relevance -- does the watershed management program address the local needs ?

2. efficiency -- are we using resources wisely ?

3. effectiveness -- are the desired results achieved ?

4. impact -- to what extent watershed management program brought about changes for the betterment of individuals.

Monitoring of watershed management program is a surveillance system used by those responsible for a program to see that everything goes as nearly as possible according to plan and that resources are not wasted or misused. Monitoring is a continuous feed back system, which is on going throughout the life of a program or project. It involves the overseeing or periodic review of each program at every level of implementation.

Monitoring involves : measuring
: recording

: collecting
: processing
: communicating the information to the management in decision making.

Monitoring insures : inputs are readily on time
: work plan are followed as closely as possible
: adjustments can be made, and corrective actions taken where necessary
: people are kept informed
: constraints and problems can be foreseen and timely solution found
: resources are used efficiently and effectively
: basis for evaluation

For example, monitoring collects information of watershed management project or program on :

1. operation processes
2. performance of program/projects
3. progress/results
4. resource used
5. overall impacts
6. social and gender aspects
7. productivity/yields
8. degree of people participation
9. equity/distribution of benefits
10. technology/information sharing
11. attitude/value
12. use of external/internal resources. etc.

and provides these information to management.

7.7 Five Year planning and Annual planning Process.

Planning is an assessment and spatial scheduling of work in order to fulfill given objectives. Watershed planning is a process of formulating and carrying out a course of action involving the use of resources in a watershed to provide desired goods and services without adversely affecting the watershed resources.

Watershed Planning is a

- Systematic management of resources
- Influence/control changes in the socio-economic variables
- Specific period of time
- Definite goals, targets or objectives.

Five Year Planning Process :

The five year planning process of government includes:

1. Review the outcome and progress of previous five year plan.
2. Identify problems and constraints encountered in the past during the implementation of the plan.
3. Identify the challenges and opportunities.
4. Identify national priorities and needs.
5. Based on previous experiences, national needs and priorities established long term vision.
6. Based on long term vision set goals, objectives and strategies
7. Prepare guidelines and directives to be followed for the preparation of the five year plan.
8. Circulate the directives and guidelines to the sectoral ministries and other institutions for the preparation their five year plan.
9. Sectoral ministries conduct interactions, meetings and consultations at district, region and central levels to identify issues, constraints, challenges and opportunities about their sectoral programmes.
10. Sectoral ministries draft their respective Five Year Plan in a format provided by national planning commission.
11. Plan should contains yearly programs, budget (both development and administrative costs), funding sources, expected outputs, beneficiaries, implementation mechanism, monitoring and evaluation plan

The Annual Planning Processes of Government includes :

1. built common understanding among staff members

2. conduct field level coaching to the users
3. identified users need and priorities through field level meeting and interactions with users
4. organize cluster level or VDC level planning workshops and set priorities
5. organize district level planning workshops involving district level stakeholders (DSCO, DFCC, Civil socity, concerned line agencies and local political parties).
6. organize Regional levels planning workshops involving all concerned stakeholders and development partners.
7. draft a annual plan and endorsed from regional planning workshops and DFCC and finally get approval from DDC.
8. submit the plan to National Planning Commission through ministry.

Basis of planning :

1. demand based on users or beneficiaries
2. supportive to achieve five year plan
3. supportive to DDC periodic plan and district watershed management plan
4. consider the NPC and ministry's criteria, norms and guidelines
5. consider present available resources both human and finance
6. consider past learning and experiences and volume of expenditures
7. focus poor, gender, socially inclusive and poverty
8. consider participation and emphasize on geographical coverage

Working Policy and Implementation Strategies adopted by DSCWM :

1. services will be provided to the districts based the priority of the deteriorating condition of watershed.
2. program will be implemented on the basis of integration and prioritizing sub-watershed
3. programs will be carried out on the watersheds of big hydroelectricity and irrigation projects
4. people's participation will be mobilized to implement the program in the functional watershe of 15 - 25 sq. km
5. priority will be given to churia and siwalik areas while implementing soil conservation and watershed management programs.
6. extension, education, training and demonstration programs will be launched in order to raise awareness among local people.

7. focus will be given to income generating activities through conservation measures to help reduce the poverty.

NPC Planning process is based on following steps :

- Review /analysis of previous plan
- Development of preliminary concept paper
- Consultation with multi stakeholders
- Prepare draft approach paper
- Consultation with multi stakeholders
- Endorse by NPC and submit to National Development Council (NDC) for approval
- Approval of approach paper from NDC
- Preparation of detail Plan document (Thematic groups of sectoral ministries , technical groups and NPC)
- Review
- Approval from NPC and endorse from Cabinet
- Plan implementation

