# NATURAL RESOURCE MANAGEMENT

## 1.1 INTRODUCTION

The need to preserve natural resources for future generations is one of the most critical issues on the national and the global agenda is the need to preserve. It also meets present day requirements. Today, the entire world has awakened to the need for sustainable development by maintaining judicious use of the natural resources and adopting developmental models and policies assuring proper environmental protection. It is well known that humans across the globe are not only polluting nature and destroying it thorough an aggressive expansion of urbanization vis-à-vis consumerism. Rightly it was pointed out by Mahatma Gandhi, that there is enough in nature for human need but not for human greed. Some 11,000 years ago, agriculture started in the lap of nature. In the beginning, it was a beautiful synergy between human technique and rhythmic nature, gradually this relationship became less friendly and finally it became tarnished. In the aftermath of the Second World War, unabated mechanization as well as increasing use chemicals have transformed our agriculture into a huge source of pollution of the environment.

## 1.2 THE MEANING AND TYPES OF NATURAL

## RESOURCES:-

Nature has been defined as the omnipresent expanse, definite and indefinite, created and evolving, having all the biotic, abiotic and social dimensions, evolving within, and around life forms and life process. The following definition may be used for understanding the natural resources: "*The sum total of all physical, chemical, biological and social factors which construct the surroundings of man is referred to as environment and each element of these surroundings constitutes a resource on which man thrives in order to develop a better life*". Any part of our natural environment, such as land, water, air minerals, forest, rangeland, wild life, fish, microorganisms, or even human population – that man can utilize to promote the welfare, may be regarded as a natural resource. There are two types of natural resources:

**Exhaustible resources** are limited in nature and liable to be degraded in quantity and quality by human activities. The examples are forests, soil, water and fossil fuels, etc.

**Inexhaustible natural resources** are unlimited in nature, and they are not likely to be exhausted by human activities, like solar radiation, air, and precipitation.

**Environment:** The environment is everything which surrounds an organism and influences its life in many ways. It includes physical and biological components.

The physical components of the environment are soil, water, air, light and temperature. These are termed abiotic components. The plants and animals are collectively referred to as biotic

components. All these components of the environment work together, interact and modify the effects of one another.

**Water:** About 70-73 per cent of the earth is covered by water. Water is available in the form of oceans, seas, rivers, lakes, ponds, pools, polar ice caps, and water vapour, and this forms the hydrosphere. The main component of the hydrosphere is water. Water exists in all the three forms, i.e., solid (snow), liquid (water), and gas (water vapour), Air: This is an inexhaustible natural resource and essential for the survival of all the living organisms on earth. In the atmosphere, about 95 per cent of the air is present up to a height of 20 km above the earth's surface. The remaining 5 percent of air is present up to a height of about 280 km. Air is a mixture of different gases; nitrogen and oxygen are the major components. Thus, the total volume of air present in the atmosphere consists of 78 per cent nitrogen, 21 per cent oxygen, while the remaining 1 per cent is made up of other gases, such as argon, neon, helium, krypton, xenon, and radon.

**Soil:** The word, soil, is derived from a Latin word, solum, meaning ground. It is a stratified mixture of inorganic and organic materials, both of which are products of decomposition.

**Sustainable Development Minerals**: The Earth's crust is rich in inorganic materials which include ores that are used on a large scale to yield metals such as iron, aluminum, copper, tin, nickel, silver, gold, and platinum. These minerals are useful in industrial and technological growth. Some of the metals are used as catalysts, e.g., vanadium, tungsten, and molybdenum. Some of the nonmetallic materials (minerals) are vital to industrial growth such as sand, fluxes, clay, salt, sulphur, phosphorus, diamonds, gems, coal, and by products of petroleum (petrol, kerosene, lubricants). Flora and fauna: Flora refers to plant species and fauna refers to animal species. The term biota includes both plants, as well as the domesticated and wild species of animals. Our country has a rich diversity of flora and fauna. There are over 45,000 plant species and 81,251 animal species. This represents about 7 per cent of world's flora and 6.5 per cent of world's fauna.

## 1.3 BIODIVERSITY: OUR STRENGTH

Biodiversity is the variation of life forms within a given ecosystem, biome, or, on the entire Earth. Biodiversity is often used as a measure of the health of biological systems. The biodiversity found on Earth today consists of many millions of distinct biological species, which is the product of nearly 3.5 billion years of evolution.

Biological diversity or biodiversity can have many interpretations, and it is most commonly used to replace the more clearly defined and long established terms, species diversity, and species richness. Biologists most often define biodiversity as the "totality of genes, species, and ecosystems of a region". An advantage of this definition is that it seems to describe most circumstances and present a unified view of the traditional three levels at which biological variety has been identified

• *Genetic diversity*
• *Species diversity*
• *Ecosystem diversity*.

One of the most pressing issues on the national and global agenda is the need to conserve biodiversity for future generations while trying to understand and document the indigenous knowledge of resource management practices. So far, this challenge has been partially addressed by the national and global agencies, which have restricted themselves to conservation of biodiversity as outlined by the World Commission on Environment and Development (1987), which led to calls for sustainable development. As a result, the model of development was foisted upon the so called Third World for the last fifty years. A strong argument has been made that development dictated from outside rather anchored in the knowledge base of the target population is, in principle, modernisation disguised, and not fully concerned with local needs. This is evidenced by the continuing marginalization of already marginalised populations in Latin America and elsewhere at a global level, and similarly, marginalisation of the tribal, pastoralists and marginal farmers in far flung and remote areas, especially in the mountain in India. Only recently, it has been realised by scholars and researchers that indigenous knowledge systems should constitute the core of development models in the Third World. Because indigenous knowledge has permitted its holders to exist in harmony with nature, allowing them to use it in a sustainable manner, it is seen as especially pivotal in discussions of sustainable resource use.

In agricultural systems, a diversity of crops and varieties is needed to combat the risks farmers face from pests, diseases, and variations in climate. Crop biodiversity also underpins the breadth of dietary needs and services that consumers demand as societies become wealthier. For some time, scientific experts have been concerned about declining diversity of crop genetic resources on farms. Many argue that the very processes that engendered the remarkable advances in agricultural productivity during the 20th century, such as the Green Revolution, also eroded the valuable stocks of genetic resources long maintained by farmers.

Sampling these resources and housing them in gene banks, while fundamental, is only a partial solution. Ex situ conservation stops the evolutionary clock and raises proprietary concerns as genetic material is transferred out of the hands of its historical custodians for safeguarding. Economists often view the loss of diversity as an unavoidable, unintended consequence of technical change and specialisation—a negative externality of progress.

In the longer term, managing crop genetic diversity through a combination of strategies and approaches (in gene banks, breeding programs and on farms) is essential for sustained social and economic development.

## 1.4 EXPLOITATION OF NATURAL RESOURCES

Number of activities relating to development including construction activities of all kinds, forest based industries, hydel and irrigation projects, mining, oil drilling, pollution, resource extraction

and road and transportation put enormous pressure on natural resource base. There are some human induced activities, which relates to agriculture, fishery, expansion of forest villages, grazing/increased domestic animals habitat, habitat depletion and exchange due to horticulture, monoculture forestry have led to different kinds of encroachment on natural resources.

**Collections made by scientific/ educational institution**

• Exploitation by local authorities as revenue resource
• Fuel wood collection
• Food gathering
• Food hunting
• Smuggling of timber/ forest produce
• Trophies/ specimen collection of medicinal plants and orchids and
• Unregulated trade / market forces.

**Human induced disasters causing stress on natural resources**

• Floods
• Major oil spills/ leakage
• Wildlife depredation
• Epidemic
• Forest fires due to humming and
• Intentional forest fire.

**Threats to NRM- wrong and faulty approaches**

• Diseases
• Fire as management tool
• Genetic uniformity
• Hybridisation
• Inadequate water and food for wildlife
• Increased competition
• Introduction of exotic species
• Lack of patronage of local / native species
• Low population/ restricted range (protectionism).

**Management of human resources**

• Change in people's life style
• Conflicting / increasing demands
• Dilution of traditional values
• Erosion of indigenous knowledge
• Generation gap
• Human harassment
• Ignorance / lack of awareness

• Inadequate trained human resource
• Inappropriate land use
• Lack of effective management
• Negative attitude
• Tourism development.

**Political and policy issues**

• Civil unrest / political movement

**Sustainable Development • Change in use/ tenure/ legal status**

• Insurgency or armed conflict
• Intercommunity conflict
• Intervention failure
• Lack of clear policy implementation
• Lack of interdepartmental coordination
• Lack of intervention
• Military activities
• People's pressure.

## 1.5 THREATS TO BIODIVERSITY

The categories of threats that follow have been recognised by the International Union for Conservation Nature (IUCN).

### Endangered

This category includes taxa whose number have been reduced to a critical level, and those whose habitats have been so drastically reduced that they are seemed to be in immediate danger of extinction, as for example Ncpenthes khasiana, Rhinanthera imschootiana, Vanda cerulean.

### Vulnerable

Taxa is likely to move into the endangered category in the near future, if the casual factors continue operating due to over exploitation, extensive destruction of habitats or other environmental disturbances. Some of the examples are Discora deltoidea and taxus wallichiana.

### Rare

This includes taxa with a small world population that are not at present endangered or vulnerable but are at risk. These taxa are usually localised within restricted geographical areas, or habitats, or are thinly scattered over a more extensive range, the examples are Farictia macrantha and Rauvolfia serpentina.

**Threatened** The term threatened is used in conservation for species which are in one of the three categories: endangered, vulnerable and rare. India's biodiversity is one of the most significant in

the world. As many as 45,000 species of wild plants, and over 77,000 if wild animals have been recorded, which comprise about 6.5 percent of the world's known wildlife. In the last few decades, India has lost at least half of its forests, polluted over 70 per cent of its water bodies, built on, or, cultivated much of its grasslands, and degraded most of its coast.

## 1.6 CONSERVATION OF BIODIVERSITY

### Why Conservation?

The Indian region is a treasure house of wild genetic resources. Wild species and relatives of crop plants contain valuable genes that are of immense genetic value in crop improvement programmes. The important wild related species and types in various crop groups, prevailing under different phytogeographic zones in the country needs particular attention in the agro-biodiversity management system for sustainable use, to help maintain food, nutritional, and agricultural economic security. The main objectives of biodiversity conservation are

• The conservation of biological diversity

• The sustainable use of components of biodiversity.

### India's efforts at Biodiversity Conservation

Dr. M.S. Swaminathan (1983) suggested the following conservation measures

• Cultivated varieties in current use
• Obsolete cultivars
• Primitive cultivars or land races
• Wild species and weedy species closely related to cultivated varieties
• Wild species of potential values to man
• Special genetic stock developed by man
• Fair and equitable sharing of benefits arising from the utilization of genetic resources.

### In-situ Conservation

• This includes conservation of plant and animals in their native ecosystems, or even in a man-made ecosystem, where they naturally occur.
• It applies only to wild fauna and flora.
• It aims at preservation of land races with wild relatives in which genetic similarities exists.

### Ex-situ Conservation

• This is done through the establishment of gene banks.
• It is the chief mode for preservation of genetic resources.
• Generally, seeds or invitro maintained plants cells, tissue, and organs are preserved under appropriate conditions.

**The drawbacks of ex-situ conservation are**

• Loss of viability over passage of time and susceptibility to insect or pathogenattack
• Inability to maintain distinct clones except for inbreed and apomicts species
• Non applicability to vegetative propagated crop.

## 1.7 MANAGEMENT OF NATURAL RESOURCES:-

There is an urgent need to think deeply about the destruction of natural resources. With the exponential increase in human population and increased technological advancement, the natural resources get relentlessly exploited. There is a need for optimisation of its usage. This is possible only when we adopt the concepts of management and conservation of natural resources. Management and conservation mean scientific utilisation of resources while maintaining their Sustainable Development sustained yield and quality. India produces only half of the national requirement of petroleum products and it imports the rest from other countries. Natural gas is the most popular petroleum product and its consumption during last two decades has increased tenfold. If we need to save fossil fuels from total exhaustion, we should encourage the usage of non conventional resources of energy, such as solar energy, wind energy, biomass energy, etc. Biogas is a natural gas. It is produced from animal, water and weeds and other plants. India comes first in developing and using biogas technology. It is a cheap, non- polluting and labour saving fuel. Biogas can be used for cooking and lighting, and in vehicles.

According to the world conservation strategy on natural resource management (NRM), it is the management of human use of the biosphere, lithosphere, and hydrosphere so that it may yield the greatest sustainable benefit to the present generation while maintaining its potential to meet the needs and aspiration, not the greed, of future generation. With the current rate of development, population growth, and migration, communities are increasingly unable to meet their sustained needs, growing demand for fuel wood and other forest products, pollution due to industrialization, and a market for rare animal species and medicinal plants have all threatened the biological diversity; and thereby have hampered sustainable human development. Further, the race for development and cultivation of improved varieties in larger areas has threatened the biodiversity to a considerable extent.

### 1.7.1 Meaning and Need for Resource Management

The main driving forces of resource consumption are population and economic growth, and the pattern of development, broadly defined to include technological level, economic structure, and the patterns of production and consumption. The projected 50 per cent growth in the global population over the next fifty years will put a significant pressure on the environment. If, over the next fifty years, the population of the developing countries achieves levels of material wealth similar to today’s levels in industrialised countries, world consumption of resources would increase by a factor ranging from two to five. Without dramatic technological improvements or changes in the patterns of consumption, growth in resource use and environmental impacts due

to increased population and economic growth in developing countries are likely to outweigh technological efficiency gains in industrialised countries.

Human wealth is based on the use and consumption of natural resources, including materials, energy and land. Continued increase in resource use and the related environmental impacts can have a multitude of negative effects leading to ecological crises and security threats.

The sustainable use and management of natural resources have, therefore, come into focus and has been the subject of many policy discussions over more than a decade, beginning with the summit in Rio de Janeiro in 1992.

Over the past 50 years, humans have changed ecosystems more rapidly and extensively than in any comparable period in human history, largely to meet rapidly growing demands for food, fresh water, timber, fibre and fuel. This has resulted in substantial gains in human wellbeing and economic development. But these gains have been achieved at growing costs in the form of the degradation of many ecosystems (Millennium Ecosystem Assessment, 2005).

### 1.7.2 Dynamics of Resource Management

Public policy in India has, for long, appreciated that access to shared or common natural resources (NR) is crucial to local livelihood strategies. Many of the rural poor depend directly on shared NR, yet they often live in ecologically marginal areas and have limited and insecure rights to NR. A recurrent question in the rural development debate has been: how are poverty and access to NR linked and what are the policy implications of these linkages? A principal conclusion has been that decentralised NR management regimes will enhance both sustainability and equitable access to NR by the poor. Policy has focused principally on institutional frameworks conferring rights, responsibilities and roles in decentralised NR management (DNRM). In India, two formal institutional systems have been identified as having the legitimacy and potential to enhance rural livelihoods: partnership models. In the last decade there have been significant moves towards formal NR management partnerships between the public administration and local user groups.

The two most institutionally evolved examples, for which Guidelines have been promulgated, are Joint Forest

Management (JFM) and Watershed Management (WM). A Constitutional Amendment passed in 1993 aimed to strengthen local government, collectively called Panchayati Raj Institutions, at District, Block and Village levels. Some of the seats at these levels are reserved for marginal and vulnerable community members, and for women. Village level Panchayats have become responsible for preparing plans for the management of NR within their boundaries. The support for decentralisation is based less on any proven success than on ideological convictions related to the importance of local involvement and self-determination in the development process. There is, however, a growing realism about the strong centralising forces within the polity and

bureaucracy that inhibit meaningful transfer of access and control over NR. Equally, earlier optimism regarding collective action has been tempered by failed participatory common resources are not considered worth collective action.

The decentralisation agenda has however led to changes in the institutional arrangements for managing shared NR. Through partnership models, and indirectly through Panchayati Raj, communities have been given some autonomy in deciding priorities for NR management, funds to develop NR assets and guidelines to promote community mobilisation.

These decentralisation initiatives represent major achievements in challenging the previous dominance of line department control over all aspects of NR management. The objective of sustainable, equitable and efficient DNRM is, however, far from being realized as our examination of the source of political demand for decentralisation and the content of the programmes and projects themselves revealed.

### 1.7.3 Management of Forests

The world forest is derived from the Latin word foris meaning outside, the reference being to a village boundary, or fence and it must have included all uncultivated and uninhabited land. Today, a forest is any land managed for the diverse purpose of forestry, whether covered with trees, shrubs, climbers, etc., or not. The Indian word, jungle, has been adopted in the English language to describe a collection of trees, shrubs, climbers, etc., that are not grown in a regular manner, as contrasted with a forest, which is any vegetation under systematic management.

*Technically, a forest* is defined below.

a) Generally, a forest is an area set aside for the production of timber and other forest produce, or maintained under woody vegetation for certain indirect benefits which it provides, e.g., climatic or protective.

b) From an ecological point of view, a forest is a plant community predominantly of trees and other woody vegetation, usually with a closed canopy.

c) From a legal point of view, it is an area of land proclaimed to be a forest under a forest law. Forestry is the theory and practice of all that constitutes the creation, conservation, and scientific management of forests, and the utilization of their resources to provide for the continued production of the required goods and services. Forests are a very striking feature of the land surface. They vary greatly in composition and density, and stand in marked contrast with meadows and pastures. The scenic effect of forests changes with the seasons like the patterns in a kaleidoscope.

Certain forests are evergreen, like the Deodar forests of Kashmir, while others are deciduous, becoming leafless either before the advent of winter when vegetative activity almost ceases, such as the oak forests of the Himalayas, or else just before the onset of intense dry summer, to reduce

transpiration to the minimum, like the Teak forests of Central India. The falling leaves in some species become bright orange or golden yellow. In others, the young foliage is pink. Such autumnal and verbal tinges are in vivid contrast with the general green or straw-coloured background, and are extremely pleasing. Unlike animals, plants do not have the power of locomotion. They also cannot construct shelters or generate heat to withstand the adverse effects of the environment of which they are captives. Therefore, to survive they wear the evidence of this fact in the form of structural adaptations, such as leaflessness in summer to minimize transpiration, thorns to ward off browsers, poisonous sap, etc.

The forests of a country are a natural asset of immense value. Unlike its minerals resources, including fossil fuels, which in course of time either get exhausted or their utilisation will become uneconomic due to increased costs for obtaining and processing them, the forests, if of adequate extent, ideally dispersed, scientifically managed and judiciously utilised can be kept perpetually productive and useful, conferring many benefits, direct and indirect, on the people. Thus, forests are a renewable resource. Directly, forests meet the needs of small timber, fuel, bamboos and a variety of other products, including fodders which are indispensable requirements of the people living in close proximity of the forests.

They also provide the facility of grazing for their livestock, and yield a variety of products of commercial and industrial value such as structural timber, charcoal, and raw materials for making paper, newsprint, rayon, panel products, bidi leaves, gums, resin, dyes, tans, and a number of other economic products including medicinal drugs. Forests also provide employment to a large population engaged in their protection, tending, harvesting and regeneration as also in ancillary occupations processing forest raw material and marketing them. These are productive functions of the forests.

**Sustainable Development**

**i) Management of State Forests** No forest should be permitted to be worked without the government having approved the management plan, which should be in a prescribed format and in keeping with the national forest policy. In order to meet the growing needs for essential goods and services which the forests provides, it is necessary to enhance the forest cover and productivity of the forests through the application of scientific and technical inputs. Production forestry programmes while aiming at enhancing the forest cover in the country and meeting national needs should also be oriented to narrowing, by the turn of the century, the increasing gap between demand and supply of fuel wood. No such programme, however, should entail clear felling of adequately stocked natural forests.

Rights and concessions: the rights and concessions, including grazing, should always remain related to the carrying capacity of forests. The capacity itself should be optimized by increased investment, silvicultural research and development of the area. Stall feeding of cattle should be encouraged. The requirements of the community which cannot meet by the rights and

concessions so determined should be met by development of social forestry outside the reserved forests.

The holders of customary rights and concessions forest areas should be motivated to identify themselves with the protection and development of forests from whichthey derive benefits. The rights and concessions from forests should primarily be for the bonafide use of the communities living within, and around forest areas specially the tribal communities.

Division of forest lands for non forest purposes: forest land or land with tree cover should not be treated merely as a resource readily available to be utilized for various projects and programmes, rather, as a national asset which requires proper safeguards for providing sustained benefits to the entire community.

Wildlife conservation: forest management should take special care of the needs of wildlife conservation, and forest management plans should include prescriptions for this purpose. It is specially essential to provide ‘corridors’ linking the protected areas in order to maintain genetic continuity between artificially repeated sub sections of migrant wildlife.

Tribal people and forests: there exists a symbiotic relationship between the tribal people and the forests, which means that both depend on each other for their survival and existence. Therefore, the primary task of all agencies responsible for forest management, including the forces development corporations should be to associate the tribal people closely in the protection, regeneration and development of forests as well as to provide gainful employment to the people living in and around the forests.

Shifting cultivation: Shifting cultivation is affecting the environment and productivity of the land adversely. Alternative avenues of income, harmonized with the right land use practices, should be devised to discourage shifting cultivation.

Forest based industries: as far as possible a forest based industry should raise the raw material needed for meeting its raw material requirements. Forest based industries must, not only provide employment to the local people on priority, but involve them fully in raising trees and raw material.

Forest extension: forest conservation programmes cannot succeed without the willing support and cooperation of the people, a direct interest in forests, their development and conservation, and awareness of the value of trees, wildlife, and nature in general.

Forestry education: forestry should be recognized both as a scientific discipline as well as a profession. Agriculture universities and institutions dedicated to the development of forestry education should formulate curricula and courses for imparting academic and professional excellence, keeping in view the manpower needs of the country.

Forestry research: with the increasing recognition of the importance of forests for environmental health, energy, and employment, emphasis must be laid on scientific forestry research necessitating adequate strengthening of the research base, as well as new priorities for action.

**ii) Promote More Public and Private Forests**

The issue of sustainability has twin challenges of environmental degradation and rural impoverishment. In many developing countries including India, conservation for sustaining natural resources sometimes become very fundamentalist and results against the people. But natural resource management must have to be done in a productive manner which benefits the local community. About one-third of the Indian population lives below poverty line and most of them live in rural area and dependent on the forests and other natural resources. Managing the natural resources effectively with the involvement of local community can play a great role in reducing poverty and environmental degradation. Promoting public and private forestry is both environmentally and socioeconomically desirable, given the multiple roles that forests can play in the provision of food, livelihood and the maintenance of the natural resource base. The concept of sustainability implies ideas about forest stewardship and quality of life. Forest stewardship means the active investment of time, money, knowledge, and other resources into the management of forest for the benefits to the public and future generations. Forest based industries have a great role to play. They should fund the local people to plant trees and manage them and meet the requirement of the industry from those community or private forests in a sustainable way. The National Forest Policy of 1988 also declared that forest based industries shall increasingly meet their requirements from private lands and forests. This will decrease the pressure on the natural forests and wildlife. Proper land exchanges between public and private as well as government sectors can also support conservation of critical natural resources. Recognizing the private property rights held by indigenous communities and compensating them for continuing to conserve their private or community owned forest resources can lead to effective and efficient sustainable management and conservation of forest resources. Community using the surrounding natural resources traditionally acquires good practical knowledge and skill of judging the condition of those resources. These people with great indigenous knowledge can manage community forests by getting economical and institutional help from government in an efficient way. Active involvement of Village Panchayats (forest councils) is very crucial to implement the community forestry. Some states in India has legal framework to manage forests by community rather than forest department.

Uttarakhand has a Sustainable Development long history of local peoples' participation in forest management. The Van Panchayats have been managing the forests surrounding the villages for a long time in the region though the forest area managed under Van Panchayat is relatively very low. Given more funding and power to the Van Panchayats would encourage the local people in forest management.

### 1.7.4 Promote Non-conventional and Renewable Energy Sources

Growing energy needs and environmental protection are two major challenges today. Energy production by burning conventional fossil fuels is responsible for the global warming and significant levels of air pollution. But access to sustainable energy services is necessary for economic growth. Increasing the renewable energy capital is the only solution to cope with these challenges and achieving sustainable development as it reduces the dependency on fossil fuel resources and provides opportunities for mitigating greenhouse gases. Technological improvement of renewable energy resources has been carried out for last decades and a number of renewable energy resources have been discovered.

i) Hydro energy

Hydro energy is one of the oldest sources of energy. Today over 80% of all electricity produced by renewable sources is produced by large hydroelectric dams. But there have been some devastating negative impacts of large hydro projects on the environment. Hydro turbines in hydro projects produce electricity by converting hydraulic potential energy of water into the mechanical kinetic energy of the turbine runner, which in turn is converted into electrical energy by the generator. In a run-of-the-river system, the force of the water current applies the needed pressure to rotate the turbine, while in a storage system, water is accumulated in reservoirs created by dams and then released with huge potential energy. Small hydro projects are very popular due to its advantage to be installed in small area and lower installation cost. Depending upon the capacity of the project, Small Hydro Project can be classified as-

(a).micro (up to 100 KW), .
(b) mini (up to 2000 KW) and
(c) small ( up to 25000 KW) hydro power project.

ii) Solar energy

The Solar Photo Voltaic (SPV) technology converts the solar radiation directly into electricity without producing any noise or pollution. Remote and isolated areas can easily get power using photo voltaic plate whether it is a top mountain or an island in the middle of an ocean. Solar Thermal Device on the other hand captures and transfers the heat energy of solar radiation which can be used for thermal applications and generating mechanical or electrical energy. The United Nation's "Global Trends in Sustainable Energy Investment 2010" report said that the solar sector attracted investments worth 24 billion dollars in 2009. In the four years from end-2004 to end-2008, solar photovoltaic (PV) capacity increased six fold to more than 16?giga watts (GW) and solar heating capacity doubled to145 gigawatts-thermal (Gwth).

iii) Wind energy

Wind has considerable amount of kinetic energy when blowing at high speeds. This kinetic energy of wind is converted into mechanical energy and rotates the blades of wind tower and the connected generator, thereby producing electricity. The wind speed plays an important role for energy generation which varies with latitude, land-sea disposition, altitude and season.

iv) Bio energy

Biomass is an important source of energy with potential to generate power. Plants use the solar energy to convert atmospheric CO2 to sugars during photosynthesis and when the plant materials are combusted, energy is released as the sugars are converted back to CO2 this energy can be harnessed using bio-energy technologies viz., biogas, gasifier, biomass combustion, co-generation etc. India has huge potential in biomass energy due to large quantity of biomass available in the form of husk, straw from agriculture field, wild bushes and large quantities of cattle dung. Energy can also be generated from solid wastes. The heat produced by burning the wastes heats a water boiler which produces steam that powers a turbine to produce electricity. Some of the basic technologies for treatment of municipal solid wastes are incineration, pelletisation, pyrolysis, sanitary landfill and bio- methanation. Household and industrial waste is sent to a combined heat-and-power (CHP) incineration plant. Waste segregation is an important prerequisite of waste to energy system. In bio-digesters, the decomposing food generates methane (CH4) gas that can be used to generate electricity and fuel. It is estimated that through adoption of waste to energy technologies more than 1000 MW of equivalent power can be generated from urban and industrial wastes in India.

Ethanol is another source of bio energy. It is produced from alcohol (obtained from different crops such as sugar canes and other grains). The technology for manufacture of ethanol (dehydrated/anhydrous alcohol) involves special processing of alcohol. There are three commercial routes for the manufacture of dehydrated ethanol from alcohol. These are:-

a. Azeotropic Distillation Technology,
b. Molecular Sieve Technology and c. Membrane Technology.

### 1.7.5 Management of Soil Resources

Rapid deterioration of soil health and degradation of soil environment as a consequence of persistent nutrient depletion and operating process of erosion, salinisation, acidification, and desertification have been of concern to soil scientists in recent years, as these are posing a threat to the potentiality of our soil resources to support the increasing food demands in the future.

Soil Degradation

• Physical: soil erosion, water logging, desertification, compaction, crusting, overgrazing

• Chemical: nutrient runoff, acidification, salinisation, alkalinisation, loss of organic matter, nutrient imbalance, nutrient depletion, accumulation of toxicants.

• Biological: monoculture, pesticides and herbicides, disposal of industrial waste, toxic containing sewage water, genetic manipulation

Approaches towards soil conservation

• The primary purpose of soil conservation is to prevent soil erosion and heal the damage where it has not advanced too far to respond to curative methods.

• The land should wear a vegetative cover throughout the year.

• Engineering and agronomic practices should be applied conjointly.

Sustainable Development Reclamation of eroded lands

• Ravines should be provided with sufficient and suitable vegetative cover.

• Instead of agriculture, these lands should be reclaimed for forestry, pasture, or horticulture.

• Their deficiency in nutrients and moisture for plants growth should be improved.

• Further misuse of such land should be prevented, over transplanting by man, and fenced cattle trails.

• Vegetative cover provided, should be protected against reckless destruction by local population.

Measures for controlling soil erosion deposition hazard

• Plantation at wind breaks and shelterbelts

• Sand dune stabilisation

• Stubble mulching

• Wind string cropping

• Primary and secondary tillage

• Conserving soil moisture.

### 1.7.6 The Management of Water Resources

Ground water has been exploited in India quite substantially in the past few decades for irrigation. However, unlike surface water resources, there has been a conspicuous lack of scientific assessment of groundwater resources. Availability of this important natural resource

has been taken for granted; utilisation of ground water has not been commensurate with the available potential in a state, e.g., about 86 per cent in Gujarat and 3 per cent in Assam, indicating considerable regional imbalance. India has 4 per cent of the world's water resources. The present water demand of India's agriculture is nearly 83 per cent of the total water use in the country and shall not change appreciable by the end of the century. The Ministry of Environment (1992) had made projections for water demand of various utility sectors for 2000 and 2025 AD.

Use of most of this allocated water for agriculture is confined to 33 per cent irrigated area and the remaining 67 per cent is still dependent on monsoon rains.

The disproportionate use of water in certain pockets results in wastage. Excessive use of water makes the field more vulnerable to soil erosion. Irrigation, thus, can be identified as the most important single activity responsible for agriculture induced environmental stress, although other activities such as deforestation for expanding agriculture, production oriented agronomic practices, use of fertilizers, and plants protection chemicals have their individual contribution.

Approaches towards water conservation Management at surface water resources such as

• canal water
• run-off water
• khadins
• nadis, Tanks
• Gully
• plugging
• water harvesting dams
• water spreading
• percolation tank

Management of ground water resources

The ground water resources in arid region have four major problems

• 65 per cent area has saline ground water with total soluble salt content over 3200 ppm
• Deep static water level
• Poor yield from wells
• Due to over exploitation, static water level is declining, soluble salt content have increased, and the yield is reduced

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The following methods are available for artificially recharging aquifers

• Water spreading
• Recharging through pits
• Wells and shafts
• Pumping to induce recharge from surface water bodies.

**Extension approaches for NRM**

• Creation of natural resources like forests, water bodies etc.
• Conservation of resources in an ecology niche.
• Regeneration of natural resources by organizing self-propelling processes.
• Preservation through social fencing.
• Recycling of waste water by products.
• Rejuvenation of degraded or age old resource base.
• Protection of target species.
• Pollution control through policy formulation.
• Elimination of negative factors operating in the eco-systems.
• Social fencing for protection, preservation.
• Integration of biotic, abiotic and social factors.
• Rationalisation in the use of dwindling resources.
• ITK and ITW: appropriate use and application.
• Watershed management to generate livelihood and conserve natural resources.
• Monitoring: Benefit monitoring evaluation (BME)
• Auditing is required to get accounts of depletion, and to suggest interventions
• People's participation: this is the most important and critical way to accomplish any objective in NRM.