

Rural Management Natural Resource Management



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Editorial Board

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About the Book

The Knowledge with exposure about natural resource management has become an indispensable requirement for the people working in any sector; be it agriculture, manufacturing, textile, information technology etc. It has, over the years, become a prerequisite for the development of a particular country and the world as a whole. Institutions providing courses on natural resources and its management promotes not only awareness about the topic but also develops, in the student, a capability to think and come up with innovative ideas for effective and efficient usage of natural resources wisely, constructively and positively.

On the pretext of this effective and efficient usage of natural resources this book provides various chapters which will help students in developing an understanding about the natural resources and the techniques that can be used in the management of the same. Moreover, the student is advised to not only be confined to the learning of this book, but should try to correlate the learning to the outside environment hands-on.

The book is about learning and finding new ways to manage the challenge of ever increasing and ineffective usage of natural resources. In the chapters, the student will attain basic knowledge about natural resources and the role that local, state and central government play in the management of the same with distinct focus on water management, land management, forest management, energy management and climate change.

It is also advised to the student taking this course to diligently work on the to-do activity part and model questions added at the end of various units to imbibe the content more clearly.

I thank Abhinav Verma, Nikita Lalde and Arkopal Saha, IRMA for contributing to this book and for their outstanding insights. Also, I would like to thank Mr B S C Naveen Kumar, Senior Faculty, MGNCRE and all MGNCRE Team members for extending their extreme support in completing this text book.

Dr W G Prasanna Kumar
Chairman MGNCRE

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Chapter 1 Natural Resource Management with a Special Focus on Water

Introduction

Natural Resource Management suggests to the administration of regular resources, for example, land, water, soil, plants, and animals, with specific consideration on how management influence the personal satisfaction of both present and people in the future (stewardship). It unites land and water usage patterns, bio-assorted variety preservation, and the future manageability of ventures like agribusiness, mining, the travel industry, fisheries, and varied range of services. It perceives that individuals and their vocations depend on the wellbeing and efficiency of the usage of natural resources, and their activities as stewards of the planet earth assume a basic job in keeping up this wellbeing and productivity for sustainable growth.

Natural Resource Management explicitly centres on a logical and specialized comprehension of resources, biology and the life-supporting limit of the resources. Environmental Management is similar to common resource management. In scholastic settings, regular resources are firmly identified and studied with natural resource management.

Objective

1. Develop an appreciation for the natural and ecological types of the state
2. Comprehend the recorded significance of natural resources in the monetary advancements
3. Comprehend the effect of changes in ways of life and the financial base of the area and the state and the suggestions for natural resource management especially water resource

Chapter Structure

1.1 Natural resources and their classification
1.2 Sustainable management and utilization of natural resources
1.3 Role of local governance in managing natural resources
1.4 Water Resource Management
1.5 Watershed Management

1.1 Natural Resources and its Classification

At the point when individuals utilize a land area to produce harvests of a crop, for example, maize, rice or wheat, actually they are utilizing soil for fixation and growth, furthermore, water as a means to provide nourishment for that crop. A natural resource is an inventory of something from the common habitat that individuals use with its specific benefit to them. For quite long-time, individuals have utilized the resources accessible in their readily available condition for nourishment, shelter and clothing. Our planet has enormous supplies of regular resources that we need for our

survival. However, the greatest challenge is to utilize these resources without destroying or degrading the nature. Our satisfaction and survival rely upon our capacity to utilize, as opposed to mishandling of the earth's resources.

Natural Resources: Definition

Natural resources are the resources that exist in their natural form i.e. without any action taken on them by human beings. On our planet, natural resources include land (including all minerals), water, air, sunlight along with crops, vegetation and animal life that naturally remain upon or within the previously acknowledged characteristics and substance. (Source: Wikipedia)

Natural resources take years to develop or form without human interference. The earth is abundant with natural resources with the surrounding climate. Natural resources that come from environment are used for our survival such as water. Also, natural resources come to our help in the form of fuel, gas, and oil which are used to meet our daily needs.

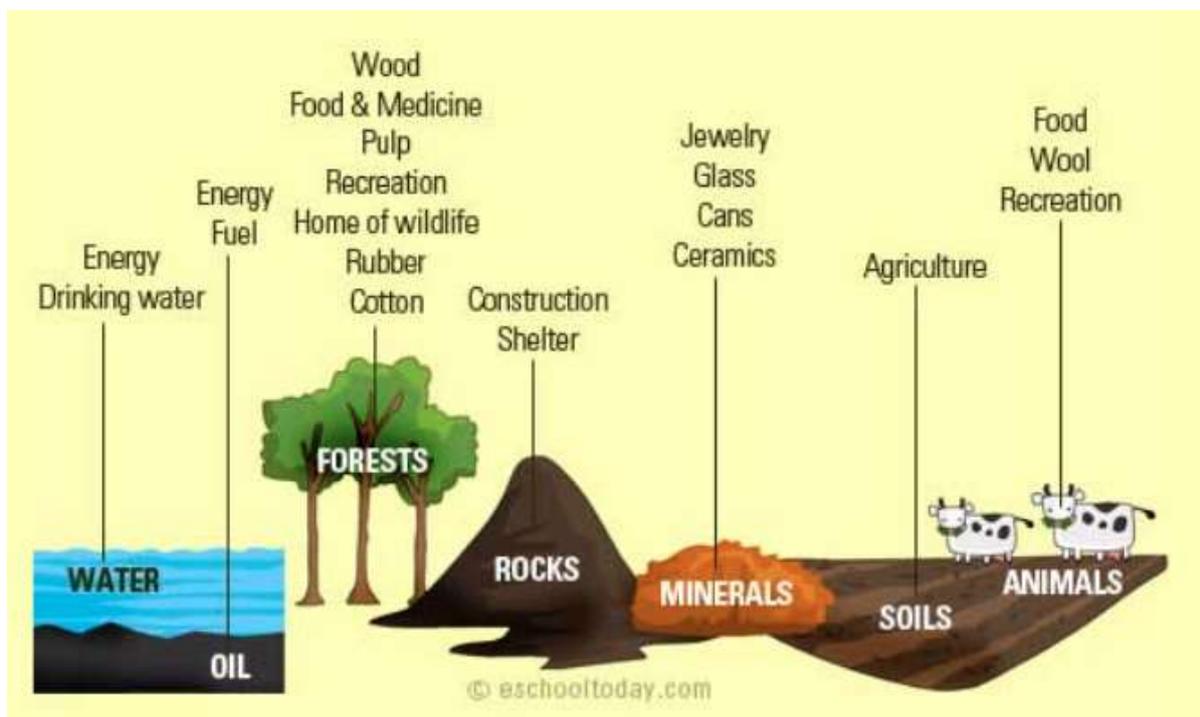


Figure 1-1 Types of natural resources¹

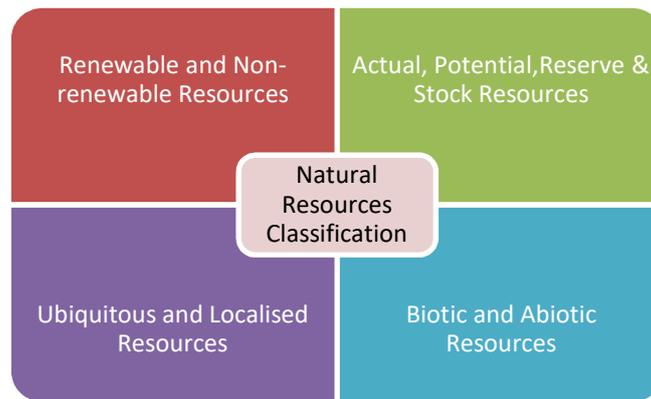
With the world's population reaching almost 8 billion, the problem is also becoming a matter of resource management. Conservation is one thing to be performed, but as the population increases, demand for the resources increases. Another concern is that, as economically growing countries continue to make strides in industrialization, their demands for resources will increase. It's not just that we should be prepared to respond for a rise in the demand of resources based on a rise in the percentage of usage of resources per billion people (as economies expand and become more modernized) the concern for the fair use of natural resources often rises in proportion to population and industry.

Classification of Natural Resources

Natural resources can be categorized in several ways. First of all, there are both renewables and non-renewables. Second, a distinction could be made between actual resources, potential resources,

¹Source: eschooltogay.com

and stock resources. There are also ubiquitous resources and localized resources. Also, we may assume that there are biotic and abiotic resources. Many of these sections are set out below.



are biotic and abiotic these sections are

Figure 1-2 Classification of natural resources

- **Renewable versus Non-renewable Resources**

Renewability is a very popular issue and many natural resources can be classified as either renewable or non-renewable resources. Renewable are the resources that can be naturally replenished. Some of these components are available on an ongoing basis and their quantity is not significantly affected by human consumption. Their regeneration exceeds human consumption. Examples of renewable resources are sunlight, wind and geothermal energy. Non-renewable resources are resources that form extremely slowly and do not naturally form in the climate. Examples include minerals such as petroleum, uranium etc. It should be noted, however, that uranium is depleting in a normal way as it is converted into heavy metals. These metallic minerals can be recycled, although fossil fuels cannot be recycled.

Another way to label renewable and non-renewable resources is by defining them as exhaustible and inexhaustible resources. Inexhaustible capital will not be depleted or exhausted in the foreseeable future. Exhaustible resources have a finite quantity and, as a result of overconsumption, will be consumed in the event of overproduction.

- **Actual, Potential, Reserve & Stock Resources**

Another way to identify natural resources is by separating them into potential, real reserve or stock resources. Actual resources are the resources that have been identified, their quality and quantity being measured and are in use at present. Potential resources are those that exist and are known to exist but are not (yet) generated. The real resources are those at a further stage of development. These are currently being manufactured and used. Technology and costs are extremely important for manufacturing. If the cost of producing a resource is too high but may be lucrative in the future, it is referred to as a reserve resource. Stock resources are those that have been identified but cannot (yet) be used due to a lack of technology. Time may bring the necessary technological advancement to bear to produce resources at appropriate rates of utilization and allocation costs.

- **Ubiquitous Resources versus Localised Resources**

Many of the natural resources can be found everywhere. Such commodities are known as ubiquitous resources. Examples are sunshine and wind. On the contrary, most of the services are dispersed resources, as they exist only in limited areas. These resources are termed as localised resources.

- **Biotic and Abiotic Resources**

Biotic products are extracted from living and organic materials, such as flora and fauna, and materials that can be obtained from trees and animals. Examples of biotic wealth include crops, in fact, also fossil fuels. Abiotic products are those extracted from non-living, non-organic material. Examples are freshwater, gold, silver, and ground.

Need to Manage Natural Resources

Today not only roads and houses, but all the items we use or consume like food, clothes, books, toys, furniture, equipment and vehicles are derived from the resources obtained from earth. The only thing we get from the outside is the energy from the Sun. Even this energy is being absorbed by living organisms and various physical and chemical processes on the earth until we make use of it. So, it has become very important to use all the resources wisely. The demand for all services is growing at an unprecedented rate, as these resources are not infinite and the human population is increasing at an immense rate. The management of natural resources thus, requires a long-term outlook, so that it will last for generations to come and not be simply exploited for short-term gains. This management should also ensure a fair distribution of resources so that everyone, not just a handful of rich and powerful people, will benefit from the production of these resources. Another aspect to be included in the use of these natural resources is the harm that we do to the ecosystem when these resources are either collected or used. For this purpose, sustainable natural resource management often needs us to prepare for the safe disposal of these wastes.

Availability of Natural Resource

The quantity and quality of natural resources have a critical effect on the country's economic development. Between the natural resources, we usually include land and soil quality, forest wealth, good river network, minerals and oil deposits, healthy and well-to-do environment, etc. The productive potential of a nation depends largely on the available natural resources. Without a minimum availability of natural resources, any sizeable economic growth is not possible. Nevertheless, it should be remembered that the availability of natural resources is not a sufficient condition for economic development. Many countries are endowed by nature with good and adequate resources, yet it is poor and underdeveloped. This is because natural resources have not been adequately used and fully exploited.

The word "natural resource availability" conjures up the converse at once, which is "natural resource scarcity." Since scarcity is essentially the topic of economics, this entry is fundamentally about the economics of natural resources, whether or not resources have become scarcer or not, and whether such scarcity will prove to be a hindrance to economic growth- an objective that most economists take for granted. The concerns addressed would, therefore, include the possible effect of reduced availability of natural resources on future development and use on human well-being in general. To some degree, on the dynamic relationship between natural resources and their ecological infrastructure which is increasingly recognized not only as necessary to sustain economic activity but also for the survival of human being.

1.2 Sustainable Management and Utilization of Natural Resources

On the 1st of August, the world hit Earth Overshoot Day, the moment in our calendars where we continue to use more natural resources than the earth will recover in a year. According to Global Footprint Network, a not-for-profit organization, that calculates how the world's natural resources are managed, "In the first seven months of the year 2018 we devoured a whole year's worth of resources, such as consumption of water for producing food to clothes".

We are utilizing energy and environmental services as if we had 1.7 Earths, and such an ecological overshoot is only possible for a short period before ecosystems begin to fail and eventually collapse. If global biodiversity continues to decline rapidly, the health and functioning of key habitats such as

forests, seas, rivers, and wetlands would be affected. Coupled with the impacts of climate change that are apparent in the alerts from scientists and the growing frequency and severity of extreme weather events worldwide; this is going to be devastating for the ecological equilibrium of the world and our future. Earth Overshoot Day is a strong reminder of the urgent steps that people, countries and the global community will take to protect trees, seas, biodiversity, and freshwater resources and to help achieve sustainability and sustainable development for all.

Every day new proof of our adverse environmental effects is emerging. The last five years have been the warmest five-year period ever, the Arctic warmed even faster than expected, and the UN reports that over the past 10 years, climate-related disasters have caused \$1.4 trillion of damage worldwide. For just over 40 years, the planet has seen a 60% decline for biodiversity across land, sea, and freshwater and is moving for a staggering two-thirds decline by 2020, if current trends continue-happened in less than a century. Forests are under threat as never before with relentless deforestation, and 90% of the world's fish stocks are overfished at sea. A similar trend of overuse and overexploitation is seen on other natural resources as well, causing inevitable stress on the planet and an ever-increasing demand for technologies to utilize the available natural resources more effectively and efficiently.

Technology for Conservation of Natural Resources

It is time to concentrate on solutions that we know exist or have the ability to create, and this is where technology, combined with behavioural change, can help us re-launch the wellbeing of our environment and planet earth. From the high seas to the depths of the densest forests in the world, technology can transform how we recognize, quantify, monitor and appreciate the many services and resources this environment offers.

Technologies used for the conservation of various natural resources include:

Conservation of Water and Land by Good Agriculture Practices

The future of agriculture depends on the management of crucial natural resources mainly, soil and water. The soil quality, prospect of water scarcity, use of chemical fertilizers and pesticides has become a challenge to agricultural productivity. Technologies to mitigate the risks involved with agriculture include:

Soil Management Techniques

Promising soil management techniques include mulching with organic matter, application of manure and bio-solids, controlled grazing, cover crop to be used in rotation cycle, agro-forestry, appropriate use of water and irrigation facilities, contour farming, hedgerows, terracing, plastic mulch for soil erosion, no-till or conservation tillage, crop residue retention, and integrated nutrient management including judicious use of fertilizers.



Figure 1-3 Plastic mulching to reduce the water lost from the soil due to evaporation



Figure 1-4 Contour farming²

Climate and Weather Prediction

Increased climate and weather forecasting capabilities will be helpful for farmers. Unless farmers could forecast drought or the start of the tropical rainy season more accurately, they would not be better equipped to make crucial timing and management decisions. Climate models, databases and tracking systems are taken for granted in other parts of the world, but these resources also need to be created for developing and underdeveloped nations like sub-Saharan Africa and South Asia. Special attention is required to ensure that farmers can effectively access and use the information that is produced while developing these capabilities.

Integrated Water Management

A combination of efficient, on-farm water capture, storage, pumping, field application, and drainage technologies may help address water challenges. Water management techniques include pipe wells, on-site storage tanks, and effective irrigation methods. Subsurface drip irrigation, in which buried tubing delivers water directly to the root areas of the plant, is the most effective method of irrigation technology, but it is currently costly.



Figure 1-5 Drip Irrigation³

² Contour farming helps in conserving rainwater and reducing soil losses from surface erosion

³ A micro-irrigation technique with the potential to save water and nutrients by allowing water to drip slowly to the roots of plants, either from above the soil surface or buried below the surface

Soil-Related Nano-materials

The emerging field of nanotechnology is promising to develop advanced agricultural technologies, such as nanotechnology-based soil modification, which will allow for better control of the conditions for or timing of the release of fertilizers. Such products can also help to remediate soil toxic substances that can hinder the growth of plants and beneficial soil bacteria.

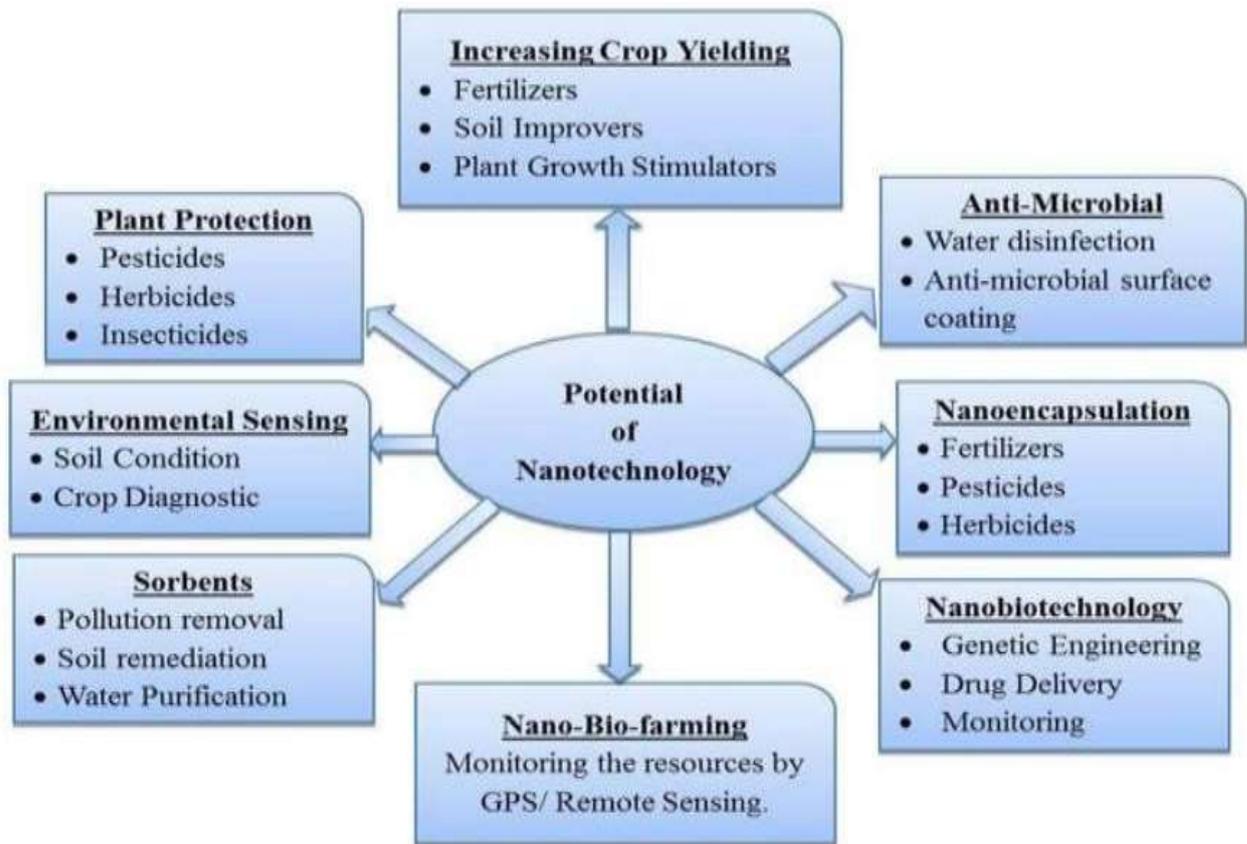


Figure 1-6 Application of nanomaterials in soil and agricultural sector

Manipulation of the Rhizosphere

Current work indicates that it is possible to exploit the rhizosphere of plants (where the roots of plants interact with the surrounding soil) by modifying their root structures for improved water and nutrient absorption and increased yields. Also, chemical signals produced by plant roots can be used to control soil microorganisms in ways that reduce the need for extra-farm nutrient inputs.

Remote Sensing of Plant Physiology

Remote sensing technologies may potentially allow farmers to track the biological status of their plants and make management decisions based on that knowledge. Increasingly sophisticated optical imaging equipment (both hand-held and satellite-based) can detect subtle variations in plant physiology, such as the presence of disease or the rate at which the plant uses nutrients. Farmers may obtain remote information through cell phones or the Internet and take appropriate action, such as irrigating or fertilizing their crops. Although it seems to be an unlikely resource for poor farmers today, remote sensing has the potential to become a realistic and useful decision-making method.

Table 1.1 Conservation technologies used to address conventional farming issues

Problem Area	Conventional Farming	Conservation Technologies
Deficiency of Nutrients	Corrected by using inorganic fertilizers	Relieves on efficient control of nutrients by biological regeneration, plus selective use of organic or inorganic fertilizers. This requires, where possible, the incorporation of livestock processing for the recycling of nutrients.
Deficiency of Water	Corrected with irrigation facilities	Emphasizes the management of soil organic matter (use of cover crops and mulch) for effective rainfall capture, soil moisture conservation, and focused irrigation.
Erosion Control	Corrected by physical barriers	Minimizes erosion by reduced or no-till activities, along with the preservation of cover crops/residues in arable cultivation and the management of vegetation in non-crop circumstances.
Soil structure deficiencies and compaction	Improved with intense tillage, which further decreases organic degradation and soil carbon	Restores land use cover crops, forest control, crop rotation, and minimum / zero tillage.
Pest management	Calendar use or need-based spraying of crop protection chemicals	Manages insects, weeds, diseases and other pests using IPM strategies that are economically, environmentally healthy and socially appropriate.
Environmental degradation	Corrective steps include changes in intensive tillage and associated management practices, which offer inadequate protection against soil erosion and secondary damage by silting and pollution of surface and groundwater from the leaching and run-off of applied chemicals.	Reduces soil erosion, water runoff from farms and greenhouse gas emissions.
Loss of biodiversity and wildlife habitat	Intensive soil cultivation, planting of different biotypes over large areas, inputs used during crop production. Higher productivity through intensification would slow the expansion of agriculture to vulnerable and marginal regions.	The additional cover offered by crop mulch promotes the diversity of micro-fauna and flora and other wildlife species. Sustainable rises in productivity from developed areas avoid the expansion of agriculture to new areas.

- **For Conservation of Forest and Wildlife by WFF**

In this topic, we will be discussing cases about the efforts WWF (World Wildlife Fund) is putting to protect wildlife with the help of the latest technologies. These cases provide a better understanding of the use of technology for the prevention of natural resources.

Blockchain to Rotationize the Commodity Markets

WWF (World Wildlife Fund) in countries like New Zealand, Australia and Fiji have joined forces to fight against illegal fishing and slave labour in the Tuna fishing industry using blockchain technology. "From bait to plate" developments in blockchain technology will help customers monitor the entire journey of their tuna—and potentially other agricultural goods and fish by rotationizing certification and traceability systems. Satellite data and cost-effective GPS monitoring tools can also be used to 'see' and understand global fishing and global shipping traffic.

Remote Sensing in Planning and Monitoring

Remote sensing plays a significant role in the preparation, tracking, and assessment of the effect on the environment. It has helped WWF to efficiently track the growth of extractive industries in socially and ecologically sensitive areas, including places like World Heritage sites. WWF is also collaborating with NASA's Jet Propulsion Lab (JPL) and UCLA to develop an algorithm to detect palm oil deforestation using remote sensing data, and they are exploring the potential to extend this technology to other commodities as well.

Drones and crowd-sourcing support to monitor forest health and detection of illegal logging

Protecting the world's forests signifies that land, in the right places, is preserved or restored as well as safe, providing people and animals with what they need to live, such as clean air and water, food and employment. And that is where the drones come in to play, acting as eyes on the trees. And it's not just the WWF that uses this equipment. WRI (World Research Institute) has created Global Forest Watch (GFW), an online monitoring and alerting program that uses crowd-sourcing, to allow anyone to create custom maps, analyse forest patterns, subscribe to warnings, or download data for their local area or the planet.

Thermal Imaging to Combat Poaching

Park rangers patrol the pitch-black savannah of Kenya's Maasai Mara National Reserve every night. They are looking for armed poachers who are pouring over the border from Tanzania to hunt for bush meat and ivory. For years, the number of poachers overwhelmed the relatively low ranger cadre. Technology is helping to turn the tide. Thermal imaging video cameras allow rangers to capture poachers at record levels and dissuade many more from even making the attempt.

Beyond direct measures to avoid smuggling, WWF also uses technology to track down wildlife traffickers. To that end, they are collaborating with a group of leading e-commerce and social media giants in the US and China to root out the selling of illegal wildlife goods on their platforms.

AI to Track Wildlife

It's hard to think about technology and nature together, but even advances like Artificial Intelligence (AI) that could not be further away from the natural environment are benefiting conservation efforts. In China, WWF and tech giant Intel are harnessing the power of AI to help protect wild tigers and their habitats, while also protecting countless other animals, while helping to preserve resources, precious watersheds, and communities in the region.

Thus, the possibilities for development collaborations to re-launch nature are infinite. The goal now is to expand this research beyond a few test sites and all the areas we're working to protect the earth. More than technology, we need a radical change in thought and understanding of the role nature and conservation plans play in our lives and businesses. When we continue to create, consume and power our lives in the way we do right now, trees, oceans and weather systems will be exhausted and destroyed. Unsustainable agriculture, fisheries, infrastructure projects, mining, and electricity are contributing to unprecedented loss of biodiversity and habitat destruction, over-exploitation, pollution and climate change.

While their impacts are increasingly visible in the natural world, the effects for people are also real. Through the lack of food and water to the degradation of the air we breathe, the reality has never been clearer. In many instances, however, we are failing to make a connection. In addition to the technological rotation, what we need is an equally unparalleled cultural transition in the way we interact with the world. In the coming units, we will be discussing in detail the various natural resources separately. This unit was devised to provide a brief introduction about natural resources and to create an understanding of the course outline.

To Do Activity

- What changes in your day to day habit can bring about a change in environment in a positive way? List out at least five things/habits.
- How can you as an individual contribute or make a difference to the management of (a) forests and wildlife, (b) water resources and (c) coal and petroleum? Prepare a report of maximum 500 words.

1.3 Role of Local Governance in Managing Natural Resources

Natural resources include land, water, forest, and energy. The governance of natural resources refers to the process of planning, administering and implementing important regulations, policies, guidelines, and norms related to the access, control, and practices for the sustainable management of natural resources at the national and local levels.

Local governance comprises a set of institutions, mechanisms, and processes, through which citizens and their representative groups can articulate their interests and needs, mediate their differences and exercise their rights and obligations at the local level. It requires a partnership between national and local governmental institutions, civil society organizations and the private sector for participatory, transparent, accountable and equitable service delivery and local development. It requires the empowerment of local governments to give them authority over resource utilization and their capacity building to function as participatory institutions that are accountable to the concerns and needs of citizens. At the same time, it is concerned with the strengthening of grassroots democracy and the empowerment of citizens, communities and their organizations (such as community-based and non-governmental organizations) to participate in local governance and development processes as equal partners.

The decentralization of governance of natural resources refers to the process of transferring decision-making powers and responsibilities (Administrative, legal and technical) from national to sub-national institutions at provincial, district, city, town and village levels. It implies capacity-building for the management of natural resources. The level of decentralization will differ from one country to another, and the degree of decentralization may be different for different resources within a country, according to the prevailing socio-economic, ecological and political conditions. In this regard, therefore, it should be noted that decentralization is a relative notion and that it does not mean the removal of central authority but rather the distribution of powers between central, state, provincial and local institutions, taking into account the subsidiarity principle.

India presents a model of decentralized governance of forest resources whereby both the central government and local governments and local communities have a stake in decision-making and

benefit sharing in forest management. These are models of joint management (or co-management) of natural resources. The above definition of the decentralized governance of natural resources signifies that the governance system was top-down and fully centralized in the first place. With the inclusion of local governance, the government is trying to bring decentralization in the management of natural resource management.

Principles about the Decentralized Governance of Natural Resources

Local governance is decentralized in nature. To make it democratic and efficient, the following principle needs to be followed:

- **Equity and justice**—All stakeholders should be recognised and legally legitimized. All the stakeholders are responsible for ownership and access to natural resources therefore rights of any stakeholder should not be breached. When equity and justice are served, there are fewer chances of marginalization of groups which is harmful to the decentralised system.
- **Empowerment** – It involves the capacity building of local institutions and communities to make them eligible for decision-making and management of natural resources effectively.
- **Accountability** – It refers to making local authorities accountable and answerable to people regarding natural resources. People trust these authorities. Therefore, authorities should ensure accountability through adequate flow of information, participatory and impartial decision-making.
- **Transparency** – It is the foundation of democratic decentralization and it can be ensured by the reliable and timely flow of information to all the stakeholders.
- **Subsidiarity** – The government should have subsidiary functions. It means that the government should not only perform those tasks that cannot be handled by local authorities effectively. It also ensures accountability by stakeholders for their respective tasks.
- **Sustainability** – The aim of this arrangement is the use of natural resources in a wise manner so that they can be utilized for the present generation and can be saved for future generations as well.

Neglecting of Common Property Resources

Common Property Resources (CPR) is defined as resources whose ownership is communal and access rules are defined as per community membership. Common Property Resources comprises common wells, forests, irrigation systems, pasture, and wasteland. CPR is a source of raw materials for many occupations such as fishermen, peasants, and carpenter, etc. to earn their livelihood. CPR comes indirectly under the main natural resource i.e. Land, Water, Forest, and Energy. CPR is often neglected while planning the conservation of natural resources. As a result, these resources are exposed to unsustainable exploitation and their continuous exploitation results in food insecurity, livelihood disappear and migration from rural to urban areas. The government has realized the importance of CPR and thus designed many participatory approaches (Discussed later in the chapter) in utilizing the resources sustainably.

The Need for Community Institutions

To make resource management sustainable, there is a need for strong institutions and rules. Local knowledge can make an effective contribution to the effective management of the resources. Therefore, the need for community institutions arises. These institutions can continuously monitor the resources in their local areas. The outside facilitator is needed to formulate institutions and rules

and regulations to run these institutions but, on the ground, execution is not possible without the locals of that particular area.

Benefits of Community Institutions

- **Financial Benefits** – Substantial benefits have been made from selling forest-based products and marine animals. By institutionalizing these communities, exploitation of resources can be prevented and profit is equally shared among all the members.
- **Non-financial Benefits** – Communities incur various non-financial such as secure livelihoods, community empowerment, cultural benefits, etc.

Participatory Approaches Led by Local Governance

The local governance cannot be undermined in the conservation of natural resources. It can play a crucial role in three ways.

- A state-initiated partnership including Joint Forest Management (JFM), Participatory Irrigation Management (PIM) and participatory watershed development (WD)
- State-initiated devolution under Panchayati Raj
- Civil society-initiated approaches including NGOs

A state-initiated partnership including Joint Forest Management (JFM), Participatory Irrigation Management (PIM) and participatory watershed development (WD)

Joint Forest Management

Joint forest management (generally termed JFM) is an innovative approach through which the Forest Department and the village community agree to jointly manage and protect and manage forest lands in and around the village. They jointly share the responsibilities and benefits of forests. The village community is known as Joint Forest Management Committee (JFMC) and also known as Forest Protection Committee (FPC) or some similar term.

The JFM started in June 1990 when the central government sent a circular to all state governments and asked them to initiate processes for involving village communities in the management of degraded forest lands (GOI, 1990). As per the report of the Ministry of Environment & Forests, more than 14 million hectares of forest land have been brought under JFM with the joint efforts of more than 63,000 FPCs and 27 state governments had passed orders for enabling JFM.

Participatory Canal Irrigation Management

Since the 6th Five-year plan, farmer's participation in joint canal irrigation is discussed. Currently, several states have started experimenting with PIM. Andhra Pradesh has started large scale execution by creating thousands of Water Users Associations (WUAs) and supported them financially. Gujarat and Maharashtra also started by setting up a few hundred WUAs but the program became stagnated after sometime. Karnataka, Kerala and Tamil Nadu also started at the same time but gain little success. Bihar and Haryana did not consider devolution seriously and made limited improvements in Canal Irrigation Management.

Participatory Watershed Management (PWM)

PWM is the most extensive and investment heavy government initiated a natural resource management program. It began as a set of diverse experiments in Sukhomajri, Ralegaon Siddi and the Operations Research Project of the Indian Council for Agricultural Research got institutionalized initially in the form of the National Watershed Development Programme for Rainfed areas in 1990. Later, Project Neefarmal (2006) and Hariyali (2006) are launched under watershed development. The main ethos of PWM is meeting food and fodder requirements of humans and livestock and simultaneously developing land, water, and biomass resources.

State-Initiated Devolution under Panchayat Raj Institutions (PRI)

The underlying structure of PRI is three-tiered – Village level, sub-district level, and district level. PRIs can play a crucial role in the governance of natural resources. The traditional top-down hierarchy can be changed with the bottom-up approach with the devolution of power under PRI. The Panchayat Raj Institutions are ideally suited for decentralized natural resource management and the reasons are as follows.

- The devolution of functions of natural resource management is broadly mandated by the Constitution and each State further divides the functions between the three tiers of local government applying principles of subsidiarity through a process of activity mapping.
- There is more clarity concerning various resources and their management. There are well-defined laws and regulations to resolve conflicts.
- The likelihood of positive outcomes from decentralized resource management is more.
- People are less likely to degrade the resource if they feel a sense of ownership in decision-making and see positive returns from the careful use of available natural capital.
- It can contribute to both environmental management and the development of livelihoods.

The cost of resource management can be reduced to the manifold by the proximity of local participants. The implications of a reduction in administrative and management costs; devolved decision making is better and they can increase the active participation of communities in any participatory program formulation.

Holistic Rural Interventions

A participatory approach for preserving natural resources has been promoted through various programs such as Joint Forest Management (JFM), participatory Irrigation Management (PIM), and Participatory Watershed Management (PWM), etc. in the past two decades. More than 30 percent of NRM programs follow the top-down approach at every stage right from planning to implementation. Lack of Institutionalization of the participatory approach resulted in the continued exploitation of natural resources. It also acted as a hindrance to the growth and sustainability of the program as a whole.

Due to the below-mentioned challenges, post-project sustainability is not possible.

- (i) The inadequate and inefficient delivery mechanism at National, State and District levels
- (ii) Poor capacity building at the Community level
- (iii) Lack of sustainability of CBOs
- (iv) Low attention towards allocation of users' right over CPR
- (v) Delay in payment of actual users for their genuine contribution by actual users
- (vi) Delay in fund flow particularly for those programs that are funded by MOA

All the interventions need to be planned systematically to ensure their successful completion and sustainability. The program level analysis of Holistic Rural Intervention is a seven-step approach. Step by step implementation will ensure positive results.

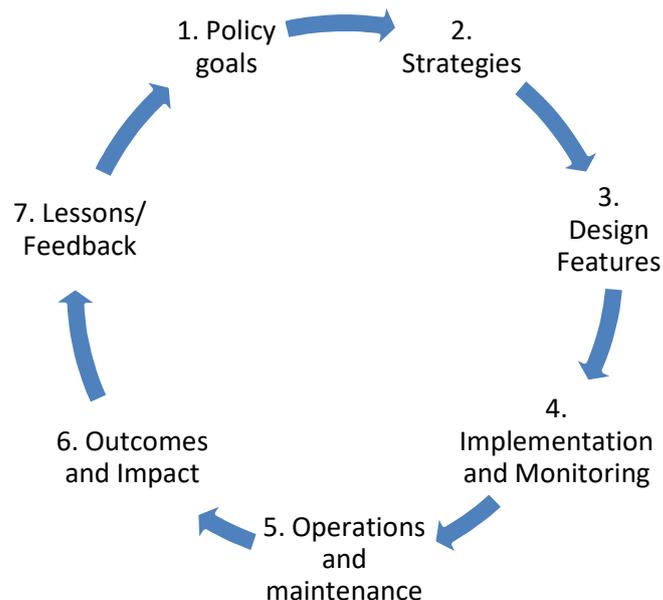


Figure1-7 - 7Steps of Holistic Rural Development Intervention

Table 1.2: Stakeholder involved and their roles in rural intervention

Steps of Rural Intervention	Stakeholders Involved	Comments
Policy Goals	Government	This step involves setting up the goals with the proposed intervention. The institutional, legal and fiscal objectives are decided in this phase.
Strategies	Government and local authority	The working environment will be different in each area and it is necessary to decide the strategies region wise. This work is done by the combined effort of government and local authorities.
Design Features	Government	The design features are decided solely by the government with the help of efforts and various researches.
Implementation and Monitoring	Implementation by local body and monitoring by government officials	The government transfers the power to the local authorities to implement the intervention. The most important task here is to ensure capacity building. The work is done by local bodies but monitoring is done by government officials.
Operations and Maintenance	Local Institutions and authorities	The day to day operations is conducted by the local authorities as they are working on the frontline in the intervention.
Outcomes and Impact	Local Institutions and audit teams	The impacts of the intervention are audited by the auditing teams to check whether the intervention fulfilled the desired objective or not.
Lesson and Feedback	Government and Local bodies	The local authorities can point out the ground level changes or lessons learned from the intervention. The government is also important at this level as it will make the changes on the central level.

Case of the Village Chitamba in Bhilwara District⁴

It is a small village of 450 households divided into nine wards or administrative units of Mandal Block of Bhilwara District. The fast depleting natural resources in the area posed a serious threat to agriculture and livelihood. This caught the attention of the community, who organized themselves and have shown exceptional perseverance and collective will in the past few years to arrest the degradation of natural resources.

In early 1990s Mangra Mewar Vikas Sanstha, an organization working on regenerating natural resources, made an effort to develop patches of land to enhance fodder availability. In 1998 Foundation for Ecological Security (FES), an organization working for eco-restoration and to establish processes of collective management and governance extended its services. FES assisted village community in shaping village specific rules and regulations, building transparent and democratic decision-making platform, encouraging transparent and accountable finances, effort to elicit meaningful and active participation of women and also building interlinks for formation of forum for reinforcing efforts for sustenance.

The Chitamba Panchayat innovatively used three institutional setups.

1. Village Institution (VI): Each habitation formalized a body with set of rules and regulations to govern common property resource within its revenue boundary. Institutional design aimed to include all users in management and governance.
2. Village institution Federation: The Chitamba Panchayat thought it important to converge the Charagah Vikas Samiti (also known as CVS and formed to manage the grazing lands) into a collective body because all faced common problems like recurrent drought, degraded common property and seasonal migration for livelihood.
3. Panchayats: This works as the only statutory body in the scheme. Chitamba Panchayat has shown remarkable volition in devolving authority to enable local village institutions to function as independent institutions.

Chitamba played a significant role not only in crafting and developing mechanisms for institutional setup only but also interlinked institutions that manage CPR and other spheres of village development. The grazing lands of Chitamba are conjointly managed by the collective action of user groups from all five habitations.

Achievements: This approach increased the women participation and also removed difference based on different casts.

To do Activity

- Apply the Holistic Rural Intervention steps in the above mentioned case.
- Prepare a report on the role of local governance on Natural Resources by stating real incident of Rural Development Intervention.

⁴ Source : Decentralization of Natural Resource Governance—a case study from an Indian village by S Joshie and A Rastogi

1.4 Water Resource Management: A Sustainable Use of Water Resources

This unit serves as a widespread reference for sustainable use of water resources. The scope stays global and macroscopic, though there may be regional differences depending on the water sources accessible in a particular setting. In fact, the thing that is regarded as “sustainable” in one place can also be a task to sustainability elsewhere. Sustainable water structures have to grant enough water extent and fabulous water fine for a given need, without compromising the future ability to provide this ability and quality. Water structures in the realm of sustainable improvement may also no longer include the use of water, but encompass systems where the use of water has traditionally been required. Examples consist of waterless loos and waterless car washes; whose use helps to alleviate water stress and impervious a sustainable water supply. Accessing the sustainability aspects in water supply, that is to say, the three-fold goals of financial feasibility, social responsibility, and environmental integrity, is linked to the reason for water use. Sometimes, these purposes compete when sources are limited; for example, water needed to meet the demands of an increasing city populace and these desires of rural agriculture. Water is used (1) for drinking as a survival necessity, (2) in industrial operations (energy production, manufacturing of goods, etc.), (3) home applications (cooking, cleaning, bathing, sanitation), and (4) agriculture. Sustainable water furnish is an aspect of built-in water aid management, the practice of bringing collectively more than one stakeholder with more than a few viewpoints to determine how water needs to great be managed. To determine if a water system is sustainable, more than a few economic, social and ecological issues have to be considered.

The Basics: Water Sources

Surface Water



Figure 1-8 Surface water⁵

Surface freshwater is lamentably restrained and unequally dispensed in the world. Almost 50% of the world's lakes are positioned in Canada on my personal (UNEP, 2002). Also, air pollution from various matters to do leads to floor water that is now no longer consuming quality. Therefore, therapy buildings (either massive scale or at the family level) must be put in place. Figure 1-8⁶ helps to visualise this.

Structures such as dams may additionally be used to impound water for consumption. Dams can be used for energy generation, water supply, irrigation, flood prevention, water diversion, navigation, etc. If correctly designed and constructed, dams can help furnish a sustainable water supply. The

⁵ Source ⁵<https://www.americangeosciences.org/critical-issues/faq/how-do-groundwater-and-surface-water-interact>

Source : ⁶<https://www.americangeosciences.org/critical-issues/faq/how-do-groundwater-and-surface-water-interact>

design wants to mirror on consideration on top flood flows (historical and projected for climate change), earthquake faults, soil permeability, slope balance, and erosion, silting, wetlands, water table, human impacts, ecological influences (including wildlife), compensation for resettlement, and one of a kind web page characteristic. There are several challenges that large-scale dams present to sustainability: horrific environmental influences on natural world habitats, fish migration, and water go with the float and quality, and socioeconomic influences ensuing from resettled nearby communities. 'Sustainability affects assessment' - have to subsequently be carried out to figure out the environmental, monetary and social penalties of the construction.

Groundwater



Figure 1-9 Ground water surfacing out

Groundwater can be a sustainable water grant provided if the whole quantity of water entering, leaving, and being saved in the device is conserved. There are three major elements which decide the supply and quantity of water flowing through a groundwater system: precipitation, vicinity of streams and one of a kind surface-water bodies, and evaporation-transpiration rate. Unsustainable groundwater use outcomes result in water-level decline, reduced stream flow, and low water quality, jeopardizing the livelihood of affected communities. Various practices of sustainable groundwater furnish and embody altering quotes or spatial patterns of ground-water pumping, growing recharge to the ground-water system, lowering discharge from the groundwater system, and altering the extent of groundwater in storage at spatial time scales. A long-term imaginative and prescient is indispensable when extracting groundwater due to the reality of the consequences of its improvement can take years formerly than becoming apparent. It is important to mix groundwater to furnish land planning and sustainable city drainage systems.

Rainwater Harvesting

Collecting water from precipitation is one of the most sustainable sources of water resource because it has inherent obstacles to the threat of over-exploitation determined in floor and groundwater sources. However, rainwater harvesting structures ought to be well designed and maintained to acquire water efficiently, prevent sickness and use sustainable therapy structures in case the water is contaminated. A variety of water consumption methods redress exists at point-of-use, each with advantages and disadvantages. These consist of solar treatment, boiling, using filters, chlorination, blended strategies such as filtration and chlorination, flocculation and chlorination. Refer the figure⁷.

Source: ⁷<https://www.dtnext.in/News/City/2018/07/30030415/1082005/Rain-water-harvesting-can-help-meet-Chennai-water-.vpf>

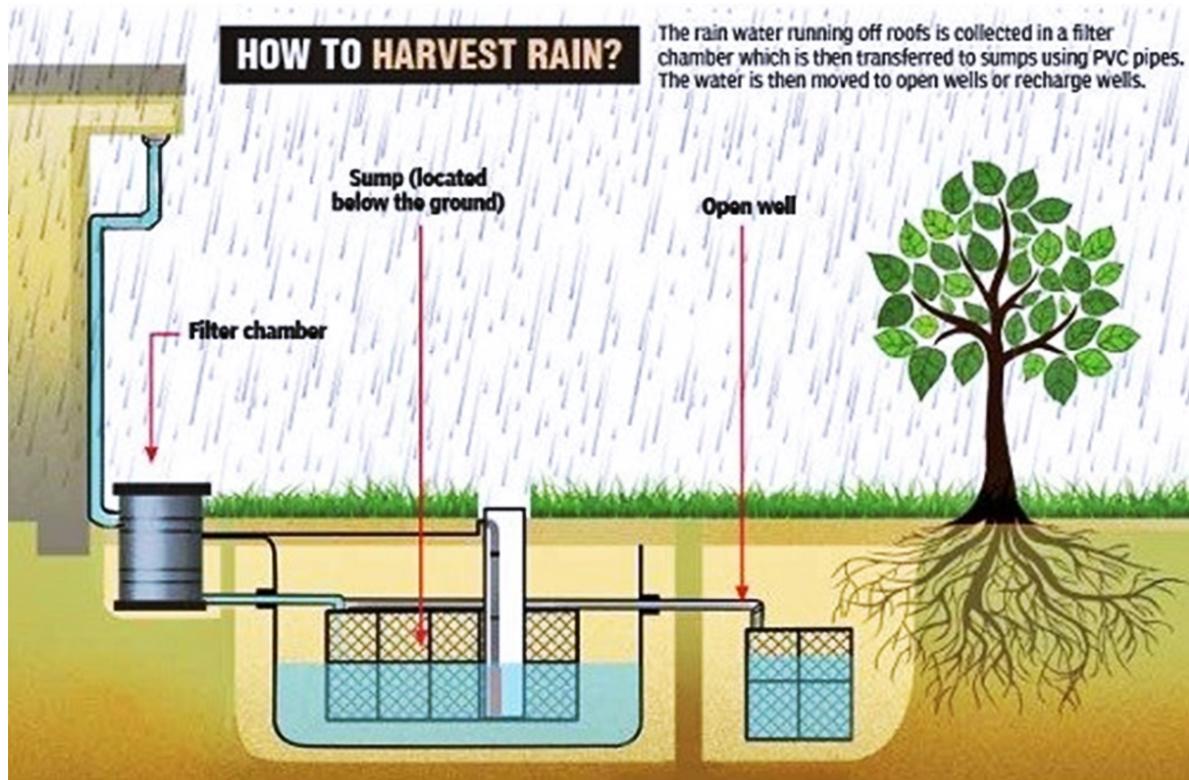


Figure 1-10 Process of Harvesting⁸

Reclaimed Water

Reclaimed water, or water recycled from human use, can also be a sustainable supply of water supply. It is a fundamental solution to limit stress on predominant water property such as surface and groundwater. Each centralized and decentralized structures consist of grey water recycling structures and the use of micro-porous membranes. Reclaimed water wants to be dealt with to furnish the extraordinary for a given utility (irrigation, industry use, etc.). It is often environment friendly to separate grey water from black water, thereby differentiating the use of the two water streams for different uses. Grey water comes from domestic things to do such as kitchen gardening and washing. Whereas black water includes human waste may not be fit for reclamation. The characteristics of the two waste streams for this reason differ.

Desalination

Desalination has the viability to furnish an adequate water extent to those areas which are freshwater poor, inclusive of small island states. However, the electricity demands of reverse osmosis, a widely-used manner used to remove salt from water is a project subject to the adaptation of this methodology as a sustainable one. If desalination can be provided with renewable energies and environment pleasant technologies, the sustainable facets of this provision would increase. Currently, desalination increases operational fees due to the reality of the wanted strength (and additionally carbon dioxide emissions). Take a look at the picture for better understanding.⁹

⁸ Source : ⁸<https://www.dtnext.in/News/City/2018/07/30030415/1082005/Rain-water-harvesting-can-help-meet-Chennai-water-.vpf>

Source: ⁹<http://carlsbaddesal.sdcwa.org/desal-process/>

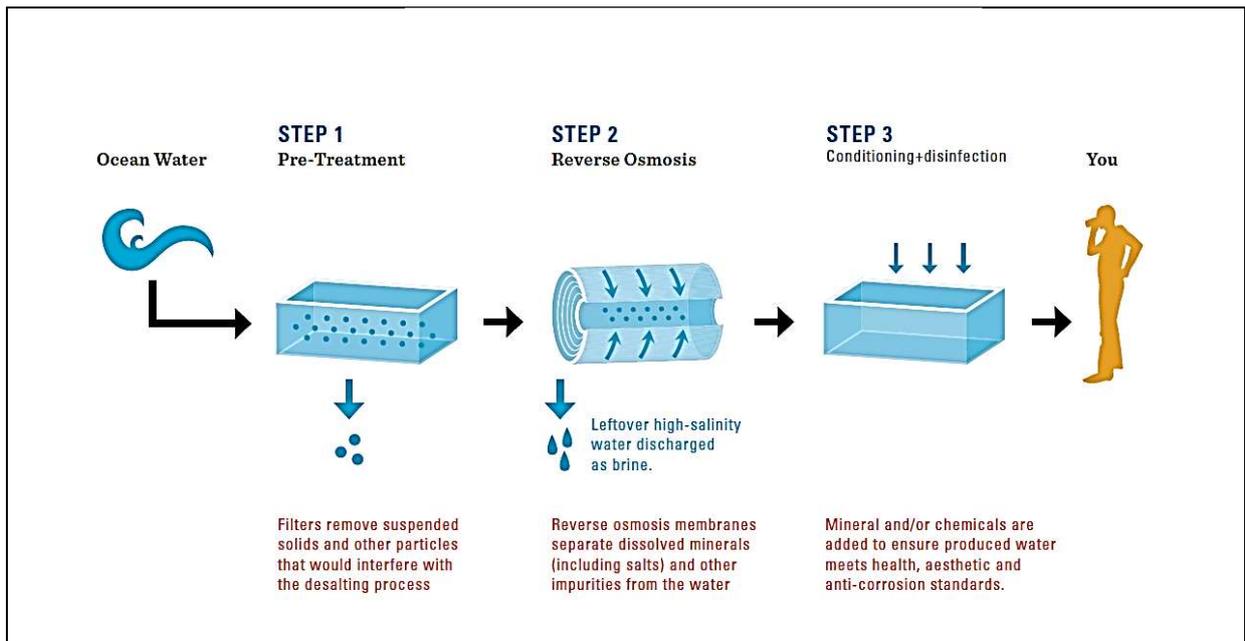


Figure 1-11 Process of Desalination¹⁰

Bottled Water

Bottled water is a twenty-first-century phenomenon whereby the complete non-public firms furnish potable water in a bottle for a cost. In some areas, bottled water is the sole dependable source of secured drinking water. However, regularly in these identical locations, the price is excessive for the nearby population to use sustainably. Bottled water is now no longer viewed as an “improved consuming water source” when it is the only potable provision at hand (UN, 2010). When sustainability metrics are used to access bottled water, it falls brief in many prerequisites of being a sustainable water supply. Economic costs, air pollution-related with its manufacturing (plastic, energy, etc.) and transportation, make bottled water unsustainable. It takes 3-4 litre of normal water to make much less than 1 litre of bottled water.

Potable Water

Potable water requires some of the strict standards to remove bacteriological and chemical pollutants. These standards are frequently governed via national governments; international suggestions that can be discovered from the World Health Organization. Drinking water must be fresh water and ought to be free of pathogens and free of hazardous chemicals.

Water in Industry

Water is used in simply every industry. Industrial water withdrawals signify 22% of complete international water use (significant regional differences exist). Sustainable water supply in the industry includes limiting water use via environment-friendly home equipment and techniques tailored to the specific industry. The rainwater harvesting (including the creation of large pond-like structures) as well as recycling water in industrial processes, can furnish a sustainable water resource for the enterprise without straining municipal water supplies. Industrial effluents release organic water pollutants, heavy metals, solvents, toxic sludge, and different wastes into the water that require proper treatment before discharge. Industry accordingly has dual accountability for internal sustainable water supply and the protection of exterior water resource sources.

¹⁰<http://carlsbaddesal.sdcwa.org/desal-process>

Water in Agriculture

Agriculture uses the biggest amount of freshwater on a world scale. It represents roughly 70% of all water withdrawal worldwide, with more than a few regional differences. The productiveness of irrigated land is approximately three times greater than that of rain-fed land (FAO, 2010). Thus, irrigation is an essential element for sustainable agriculture systems. Also, international food production is expected to enlarge via 60% from 2000 to 2030, developing a 14% expand in water demand for irrigation. Agriculture is also accountable for some of the floor and groundwater degradation because of run-off (chemical and erosion-based). It, for this reason, has a dual-position in sustainable water supply: (1) the usage of water efficiently for irrigation and (2) protecting surface and groundwater resource sources from contamination. Techniques for sustainable water supply in agriculture consist of organic farming practices which limit elements that would contaminate water, facilitate efficient water delivery, micro-irrigation systems, adapted water-lifting technologies, zero tillage, rainwater harvesting, runoff farming, and drip irrigation (the efficient method that approves water to drip slowly to plant roots by using the use of pipes, valves, tubes, and emitters).

Domestic Water Uses

The average household wishes estimated 20-50 litres of water per personality per day, relying on a variety of assumptions and practices. Reducing water use via waterless toilets, water environment-friendly appliances, and water volume monitoring, is an essential section of sustainability for domestic water supply. Efficient piping systems that are leak-free and nicely insulated furnish a reliable network and help to restrict water waste. The aforementioned potable water supply sources, with their sustainability sides and sustainability challenges, are all applicable to different domestic uses. Since water superb standards are not as strict for family makes use of as for drinking, there is increased flexibility when considering sustainable domestic water resources (including the practicable for reclaimed water use).

Need for Water Resource Management

Water Management is significant since it decides future Irrigation desires. Water board is the administration of water resources under set arrangements and guidelines. Water, a plentiful normal resource, is turning into a progressively important item because of dry spells and abuse. Water resource management is the action of arranging, creating, appropriating and dealing with the ideal utilization of water resources. Water is a basic resource for all life on the planet. Of the water resources on Earth, just three percent of it is usable and 66% of the freshwater is locked in ice tops and icy masses. At present just about 0.08 percent of all the world's water is used by humankind in regularly expanding interest for sanitation, drinking, assembling, recreation and horticulture. The strategic Water Management utilizes a gathering of distributed discoveries on Engineering standards and innovation. As of now, our essential research objective is to empower and help the improvement of better and quicker proportions of water engineering movement. In situations where we accept, we can contribute legitimately, rather than crafted by others, we are delivering our proportions of Water Management.

In the 21st century, looks into the demonstration of the way that individuals are arriving at a point where water will be as costly as mineral oil. It isn't astonishing that we have misused nature to such a degree, that there will undoubtedly be 'Water Crisis' around the world. Mahatma Gandhi properly said that the Earth has enough for everybody's needs and not the greed. Thus, ample opportunity has already passed& we start to invest in water management thinking about the accompanying following reasons -

1. To stop contamination of water bodies

- One of the significant issues that are expanding at a disturbing rate is that distinctive water bodies like streams, seas, lakes, coves, and so forth are getting contaminated because of the populace boom.
- We are losing the real measure of consumable water that ought to be available on the planet. The groundwater is misused to the fullest for the personal stakes of certain individuals. This will prompt a day when there won't be any groundwater stores left.

2. Use of the resources

- Water management helps in creating proficient water system practices for the advancement of horticulture in the nation.
- Legitimate usage of water in our homes also can spare this valuable resource. Water management instructs us to utilize a restricted measure of water at any given point of time. This keeps each resident responsible for any wastage that happens.
- We have to save water resources for people in the future. There are diverse statutory commissions set up by the legislature and NGOs who are moving in the direction of maintainable insurance of water resources. In any case, it is the grass-root level changes that bring a positive effect and residents' drive matters the most.

3. Forestall any type of cataclysmic event

- A dangerous atmospheric deviation is draining the current regular resources and individuals' fever for modern advancement is compounding the circumstances.
- There are starvations, dry seasons, floods, and numerous catastrophic situations in different nations that strike in numerous occasions.
- There are boundaries in the atmosphere and it is the abuse of water bodies that have prompted this issue. Right water management helps to conserve our nature and the current biodiversity.

Integrated Water Resource Management (IWRM)

Four guidelines or rules that oversee IWRM:

Guideline 1: Freshwater is a limited and priceless resource, fundamental to support life, advancement and the condition of living.

Guideline 2: Water improvement and management ought to be based on a participatory methodology including clients, organizers and approach creators at all levels.

Guideline 3: Ladies assume a focal job in the arrangement, management, and the protection of water.

Guideline 4: Water has a financial incentive in all its contending users and ought to be perceived as a financial return just as a social decent. With explicit reference to Guideline 3, gender orientation ought to be tended extensively to guarantee that the perspectives and commitments from the two men and ladies are dealt with fairly in moulding the improvement motivation. IWRM changes the status quo, shunning a disconnected way to deal with water resources management. Its establishment is in light of the idea that water resources are fundamental to the wellbeing of the environment. Given the danger in which atmospheric changes pose to the long-term water accessibility in SIDS (small island developing states) nations.

Such a structure ought to incorporate the following points:

1. Implementation of the following versatile methodologies:

- Infrastructural – assemble people around water bodies and seaside for raising water watchmen to control ocean level increase and flooding, and devise procedures through micro planning for enhancing water use productivity (for example dribble farming).
- Conduct – bring issues to light to alter creation, behavioural changes in utilization practices (for example productive water system).
- Administrative – change farming patterns, for instance by developing dry season safe yields that adjust to the evolving climate, and request for management’s strategies, for example, evaluating, metering and characterization of water use.

2. Change of current water management techniques all through the area by:

- Improvement, restoration, and upkeep of water structure foundation.
- Desalination, particularly in fresh water deficient nations.
- Water harvesting.
- Outfitting the potential advantages of grey water as a choice to build the accessibility of water and to address the worldwide test of wastewater management.

3. Fortifying of water resource management through evaluations of water resources, monetary evaluations of the division, water gauging and modern change, limit building, and foundation of water observing systems.

4. Improvement, structure, and usage of water arrangements, which incorporate coordinated water resource management (IWRM), national water data frameworks to expand accessibility also, availability.

5. Elaboration of economical land management practices brings it to mainstream

1.5 Watershed Management

A watershed is the geographic zone through which water flows over the land and finally drains into a typical waterway, regardless of whether a stream, waterway, lake, or sea is inundating the adjoining lands. The watershed limit will follow the most elevated ridgeline around the stream channels and meet at the base or absolute bottom of the land where water flows out of the watershed. This becomes the mouth of the waterway. Usually, plenty of the water that originates from precipitation and storm water overflows. The quality and amount of water are influenced by all the adjustments to the land - mining, agriculture, roadways, urban development, and the exercises of individuals inside a watershed. Watersheds are typically isolated from each other by normally raised regions.

Watershed management is the investigation of the significant attributes of a watershed focused on the maintainable circulation of its resources and the way towards making and actualizing plans, projects, and ventures to continue and improve watershed works that influence the plant, creature, and human networks within the watershed boundary. Features of the watershed that organizations try to look into include - water supply, water quality, seepage, storm water overflow, water rights and the general arrangement and usage of watersheds. Landowners, land use offices, storm water management specialists, natural resource masters, water use surveyors and networks; all have a vital impact in the watershed management. Watersheds are significant because the surface water highlights and storm water overflow inside a watershed at the last channel to different waterways. It is fundamental to think about these downstream effects when creating and actualizing water quality insurance and reclamation activities. Everything upstream winds up downstream. We have to remember that we as a whole live downstream and that our ordinary exercises can influence downstream waters.

Destinations of the Watershed Management

Watershed management is an endeavour to stop land erosion and an all-encompassing procedure for getting the optimum value and productivity of the land. Watershed management suggests balanced use of land and water resources for ideal and supported creation. With a touch of astuteness and judicious judgment, the down poured water can be made to descend the inclines gradually, guaranteeing ideal penetration and permeation, naturally taking care of the issue of soil erosion. Lessening the effect of the downpour on the soil, checking its speed at different interims, taking up all procedure on the shape and redirecting the abundance to forestall the pressure, is one of the methods to be visualised.

Steps in Watershed Management

1. Planning of baseline data maps with ridgelines for analysis.
2. Surveillance and study of the watershed for collecting field level data and information.
3. Evaluating precipitation qualities.
4. Planning of soil maps and grouping of grounds for various utilizations as indicated by ability characterization for farming, field cultivation, vegetative and engineering structures.
5. Planning of stock of existing area use and farm sizes.
6. Evaluation of present and potential markets and conceivable gathering activity plans.
7. Completing topographic and hydrologic reviews for building works.
8. Geo-hydrological overview to portray territories appropriate for groundwater development.
9. An incorporated time-bound arrangement for land and dampness protection, and groundwater recharge, taking up afforestation, Agri-business development & supply of safe drinking water.
10. Need identification of stakeholders for the execution of the intervention.
11. Surveying social expenses and advantages.

Land Management

Watershed management must consider dimensions of the land, since a common watershed may incorporate terrains suitable for farming, plantation of trees, pastures, and so on. The land classification may be written as follows:

Class I: This kind of land is almost level, with least erosion; the piece of land is profound, very much undeleted, with sufficient water-holding capacity. This land need normal administration practices to look after profitability. Such practices may incorporate the utilization of at least one of the measures like addition of composts, lime spread, and green fertilizer crops, and crop residue. They are fit for farming field, forests, and so on.

Class II: These pieces of land have a few constraints. They are liable to slight erosion, as they are marginally inclining lands, with less soil depth, periodic seepage issues that can be handily rectified, and they are saline at places. They may require at least one of the treatment measures on terracing, strip-editing, form development, water waste, crop rotation, utilization of green manure, stubble mulching, utilization of composts, fertilizer. These pieces of land might be utilized for agriculture, vegetable growth, raising fields, forests, and so on.

Class III: The variables that cut off plant development are more extreme than in class II. This kind of land could be moderate slanting, thereby making the land vulnerable to water or wind erosion. The land progressively is helpless to seepage issues, it a land with water-run off, shallow soil depth, low moisture holding capacity and moderately saline.

Class IV: The restrictions to plant development are more serious here than in Class III soils. Exceptionally cautious administration is required and the preservation practices are progressively hard to apply and keep up. A portion of the components influencing these grounds are steep inclines, serious weakness to water and wind erosion, shallow soils, low moisture holding limit, extreme water-run off and extreme saltiness. This piece of land can be utilized for crops fields, backwoods and untamed life growth, and so on.

Class V: This class of soils are swamps and are subject to inundated by streams which forestall the normal vegetation. It is rough or stony territory. The piece of land is reasonable for raising developed harvests that are not appropriate for perpetual vegetation yet.

Class VI: This piece of land has serious confinements that make them inadmissible for development and are low in their utilization to a great extent to fields or forests or untamed life growth and spread. The characteristics are - steep slant, serious erosion danger, shallow establishing zone, exorbitant wetness, and extreme saltiness.

Class VII: This land is highly problematic and isn't viable to embrace field improvements and water control practices.

Class VIII: Barren forests, rough out fields, sandy seashores, bogs, deserts, mine residual land and others are infertile that terrains might be remembered for this class. It might be important to give assurance and management for plant development to soils and land shapes in class VIII to ensure other increasingly significant soils, to control water, or for untamed life. This type of land needs lot of treatments to be made worthy of any fruitful purpose.

Water Management Activities

The best open doors for dampness protection lie in the control of the segment of precipitation which is typical overflow. Holding surface water on the land surface for a more drawn out time builds the measure of water entering the soil. Successful techniques are accompanying:

- Form bunding/reviewed bunding
- Check dams and gorge control structures
- Land levelling/land smoothing
- Seat terracing
- Farm lakes
- Permeation lakes
- Conduits
- Redirection channels

Water preservation begins in the highest rough territories where the spill over water should be depleted out by shaping preoccupation channels. This secures the lofty slants underneath which are fit uniquely for developing feed. While avoiding the touching in these territories guarantees ideal recovery; lush feed slice and taking care of the creatures guarantees better nourishment and wellbeing.

Purpose of Watershed Management

Watersheds support life, in a greater number of ways than one. As per the Environmental Protection Agency, more than \$450 billion in nourishments, fibre, fabricated products, and the travel industry rely upon spotless, solid watersheds. That is the reason legitimate watershed security is important to you and your locale. Watershed insurance is a method for securing a lake, waterway, or stream by dealing with the whole watershed those channels into it. Spotless, solid watersheds rely upon an educated open to settling on the correct choices with regards to the earth and activities made by the

network. Earth is canvassed in 70% water and tragically 40-half of our country's waters are weakened or undermined. "Disabled" implies that the water body doesn't bolster at least one of its proposed employments. This could imply that the water isn't reasonable to savour, swim or to expend the fish that was gotten there.

The main sources of contamination in our conduits are dregs, microscopic organisms, (for example, E. coli) and abundance supplements, (for example, nitrogen and phosphorus). Even though supplements sound like things that have a place in a solid situation, they can cause enormous issues in an ineffectively overseen watershed. For example, dregs can choke out fish by obstructing their gills and the nearness of microscopic organisms alone can demonstrate that different infections and germs can be found in the water also. Erosion, the spill over of creature waste and flooding of consolidated sewers are only a couple of ways these toxins arrive at our waters.

Types of Watershed

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

- Macro watershed (> 50,000 Hect)
- Sub-watershed (10,000 to 50,000 Hect)
- Milli-watershed (1000 to 10000 Hect)
- Micro watershed (100 to 1000 Hect)
- Mini watershed (1-100 Hect)

Variables influencing watershed management

a) Watershed characters

- Size and shape
- Topography
- Soils
- Relief

b) Climatic trademark

- Precipitation
- Sum and power of precipitation

c) Watershed activity

d) Land use design

- Vegetative spread
- Thickness

e) Social status of inability

f) Water resource and their abilities.

Watershed management practices

- In terms of direction
- To expand penetration
- To expand water holding limit
- To forestall soil erosion
- Strategy and achievement

In short different control measures are:

- Vegetative measures (Agronomical measures)
- Strip cropping
- Pasture cropping
- Grassland farming

- Forests
- Engineering measures (Structural practices)
- Contour bunding
- Terracing
- Construction of earthen embankment
- Construction of check dams
- Construction of farm ponds
- Construction of diversion
- Gully controlling structure
- Rock dam
- Establishment of permanent grass and vegetation
- Providing vegetative and stone barriers
- Construction of silt tanks detention

Impact of soil protection measures and vegetation spread on erosion, Runoff, and Nutrient loss.

Water collecting is the primary segment of the watershed of management. A portion of the watershed management structures are as per the following.

1. Broad beds and furrows

a. Function

To control erosion and save soil dampness in the land during stormy days;

b. General information

The broad bed and wrinkle framework is laid inside the field limits. The land levels are taken and it is laid utilizing either creature drew or tractor draw ridges.

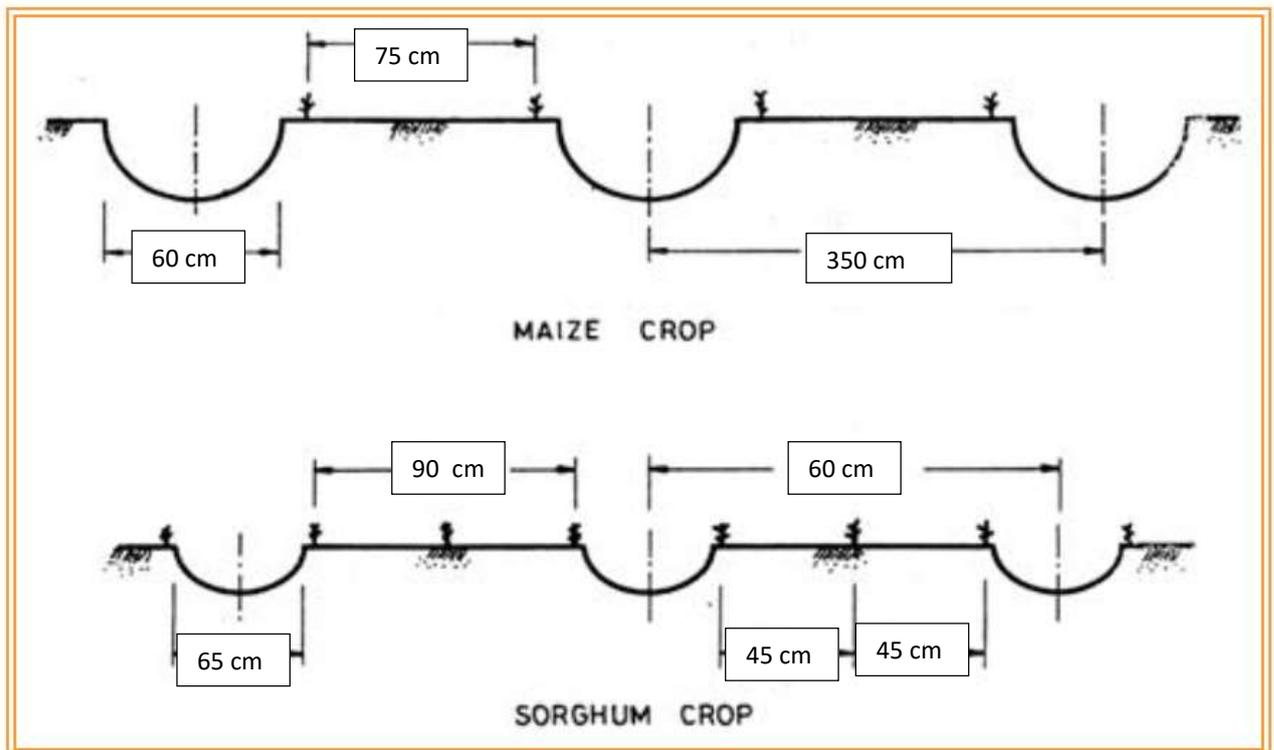


Figure 1-12 Broad beds and furrows-1¹¹

¹¹ Source: <http://terra-agro.com/Company/bhj/images/wasteland1.jpg>



Figure 1-13 Broad beds and furrows-2¹²

c. Cost

The inexact expense for laying beds and wrinkles is Rs.1800/ha.

d. Remarkable features

- Preserves soil dampness in dryland
- Control soil erosion.
- Goes about as a seepage channel during overwhelming stormy days.

2. Contour bund

a. Function

To catch the run-off streaming down the incline by a bank;

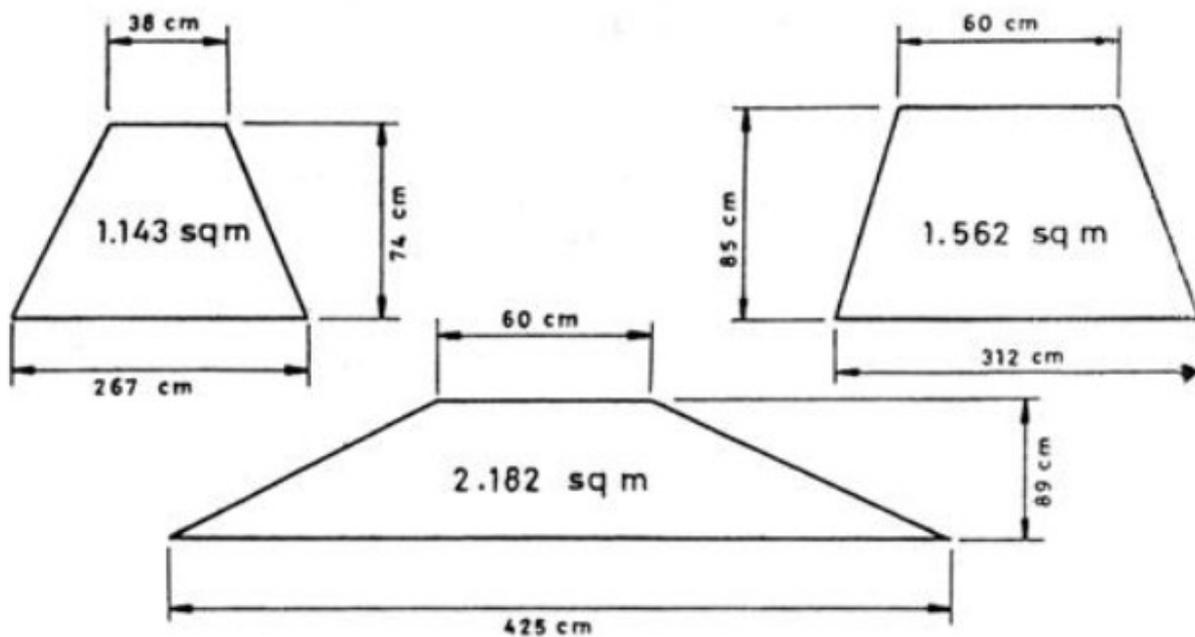


Figure 1-14 Contour Bund¹³

¹² Source: <http://terra-agro.com/Company/bhj/images/wasteland1.jpg>



Figure 1-15 Contour Bund¹⁴



Figure 1-16 Contour Bunding¹⁵

¹³ Source: <http://terra-agro.com/Company/bhj/images/wasteland1.jpg>

¹⁴ Source: <http://terra-agro.com/Company/bhj/images/wasteland1.jpg>

b. General information

It assists with controlling run off speed. The bank might be shut or open.

c. Cost

The inexact expense of laying shape bund is Rs.1400/ha.

d. Remarkable features

- It tends to be received on all piece of land
- It tends to be laid up to 6% slants.
- It assists with holding dampness in the field.

3. Bench Terracing

a. Function

It assists with bringing the slanting area into various level strips to empower development.

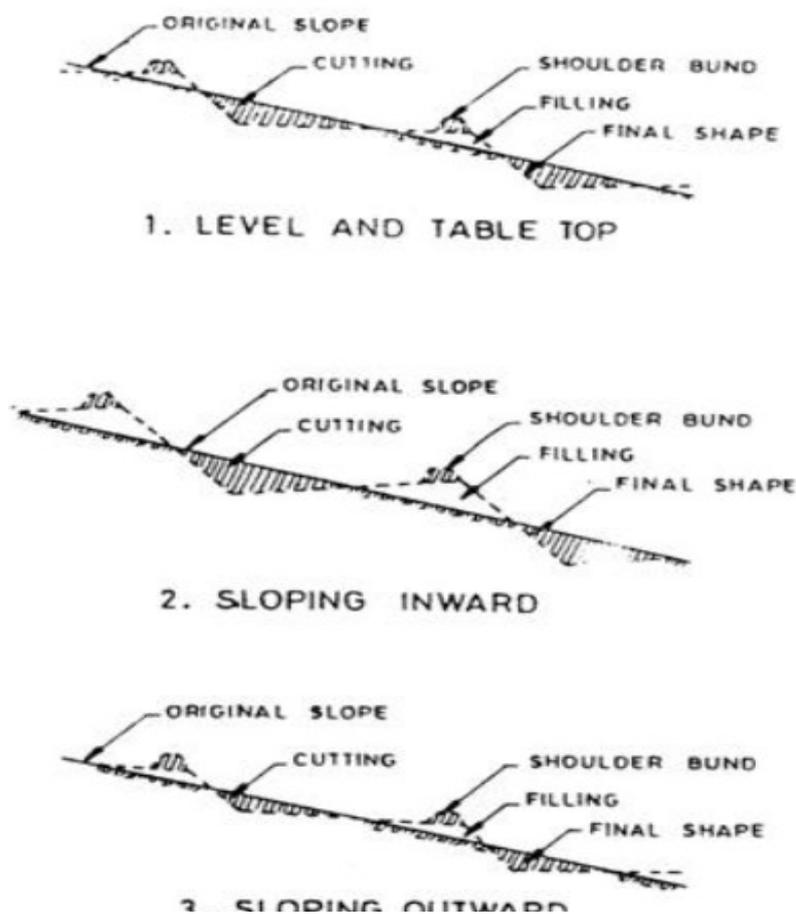


Figure 1-17 Types of bench terraces¹⁶

¹⁵Source: <http://terra-agro.com/Company/bhj/images/wasteland1.jpg>

¹⁶Source: <http://terra-agro.com/Company/bhj/images/wasteland1.jpg>



Figure 1-18 Bench Terrace¹⁷

b. General Information

It comprises of the development of step like fields along with forms significantly cutting and half-filling. The unique incline is changed over into level fields. The vertical and flat interims are chosen dependent on a level incline.

c. Cost

The estimated cost for laying the porch is Rs.5000/ha.

d. Notable Features

- Reasonable for sloping areas.
- The seats might be of internal slanting to deplete off abundance water.
- The outward slanting seats will assist with diminishing the current soak slant to mellow one.
- It is received in soils with slants more noteworthy than 6%

4. Micro Catchments for Sloping Lands

a. Function

It is valuable for insitu dampness protection and erosion control for tree crops.

¹⁷ Source: <http://terra-agro.com/Company/bhj/images/wasteland1.jpg>

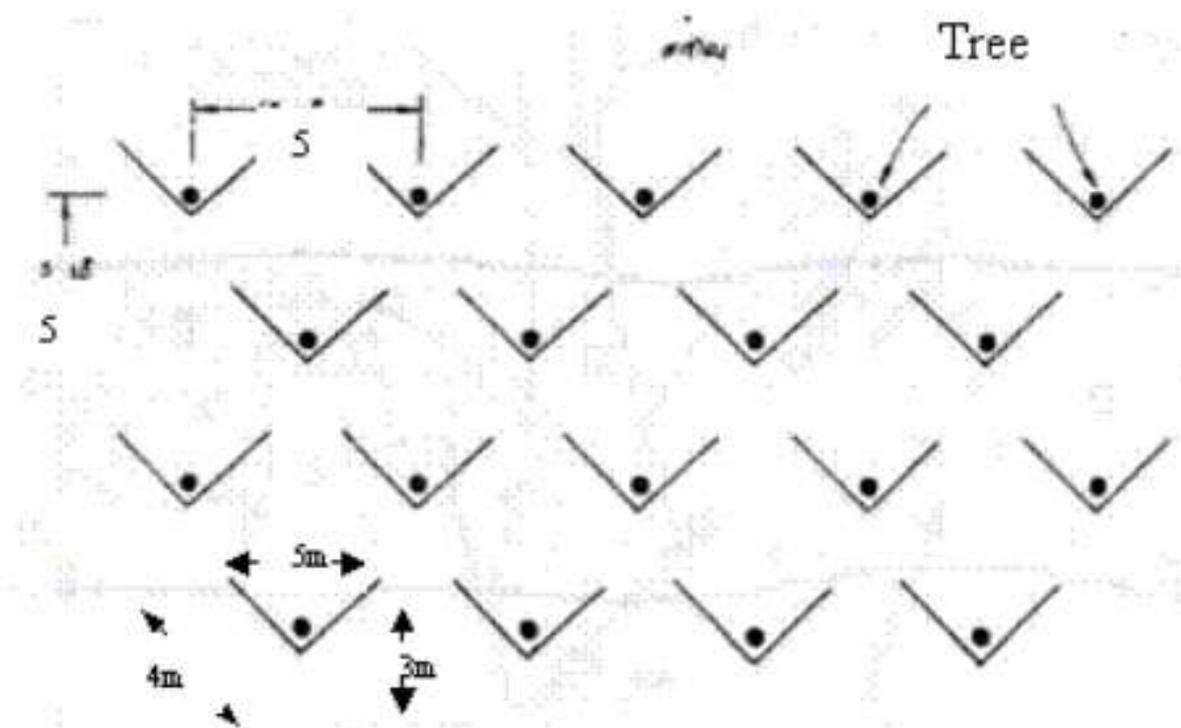


Figure 1-19 Micro catchments¹⁸



Figure 1-20 Micro catchments¹⁹

¹⁸ Source: <http://terra-agro.com/Company/bhj/images/wasteland1.jpg>

¹⁹ Source: <http://terra-agro.com/Company/bhj/images/wasteland1.jpg>

b. General Information and Cost

Technique	Storage capacity per unit (m3)	Annual run-off contribution to soil moisture Additional water stored per ha (m3)	Estimated surface Run-off control (%)
Triangular catchments (V-Bunds)	13	5200	80
Crescent bunds	10.2	4080	73

Technique	Cost/ha (Rs.)
Triangular catchments (V-Bunds)	6000-7000
Crescent bunds	2500-3000

c. Notable features

- Slant ranges from 2 – 8%
- Soil type – Light to direct surface
- Insitu dampness protection with good planting
- Reasonable for dry land Agriculture and Agroforestry
- Bund stature – 30 to 45 cm.

5. Check dam



Figure 1-21 Check Dam²⁰

a. Striking highlights

- A low weir regularly developed over the ravines
- Developed on little streams and long gorges framed by the erosive movement of rising water
- It cuts the speed and lessens erosive movement
- The put-away water improves soil dampness of the connecting zone and permits permeation to energize the springs

²⁰ Source: <http://terra-agro.com/Company/bhj/images/wasteland1.jpg>

- Separating between the check dams water spread of one ought to be past the water spread of the other
- Height relies upon the bank stature, changes from a meter to 3 meter and length shifts from under 3m to 10m
- The cost differs from Rs. 40000/ - to Rs. 100000/ - per unit

6. Percolation Lake

a. Function - To increase the groundwater levels.



Figure 1-22 Percolation Lake²¹

b. Remarkable highlights

- Best under delicate inclining stream where slender valley exists
- Situated in soils of porous nature
- Versatile where 20-30 groundwater wells for water system exist within the zone of impact around 800 – 900m
- Least limit might be around 5000 m³ for the sake of economy
- Likewise, going about as sediment confinement store
- The cost differs from Rs. 60000 to 150000 for every unit

7. Stone Barriers



Figure 1-23 Stone Barrier²²

²¹ Source: <http://terra-agro.com/Company/bhj/images/wasteland1.jpg>

To Do Activity

Explore various water structures around you. Comment on their sustainability and potential of success in the coming years. What are the questions that came to your mind while observing and learning about the utility of these water structures? How can the structures be made or revamped so as to minimise water wastage? Make a presentation in groups of 5 and demonstrate the same in class.

Summary

A water supply system will be sustainable solely if it promotes efficiencies in both the supply and the demand sides. Initiatives to meet the demand for water will be sustainable if they prioritize measures to avoid water loss. Avoiding wastage will contribute to judicious water consumption and, consequently, to delaying the need for new resources. On the demand side, the adoption of water environment-friendly technology can extensively limit water consumption. Investments in much less water-intensive industrial techniques and greater efficient constructions lead to a more sustainable water supply. Concrete probabilities of financial savings, social advantages (such as the involvement of unique sectors of society to reach a frequent objective, environmental attention of the population, etc.) and variation of environmental beneficial properties make the adoption of water-efficient technologies viable. Sustainable water usage includes a sequence of blended moves and not remote strategies. It depends on the individual's willingness to retain water, governmental regulations, adjustments in the construction industry, industrial strategies reformulation, land occupation, etc. The mission is to create mechanisms of regulation, incentives through entry point activities, and affordability to ensure the sustainability of the system. One should also remember that water and land management should complement each other since these two resources are very much interlinked in various aspects of usage and conservation.

Questions for Discussions

1. Define Natural Resources? Explain various types of classification of natural resources with examples?
2. Why there is a need for natural resource management?
3. Are natural resources available in abundance? Explain.
4. Define good agricultural practices and how these practices can help in the management of water and land?
5. What are the applications and benefits of nanotechnology?
6. What are the various technologies used for the protection of wildlife resources?
7. Why there is a need for community institutions?
8. State the benefits of community institutions?
9. What do you understand by various participatory approaches mentioned in the unit?
10. Mention various steps required for holistic rural intervention?

To Do Activity

Allow Class on a local stroll. On the walk searching for natural resources, and take notes. Upon returning to class, have students study their notes and then draw and mark pictures of the tools they have used. Make a presentation about the kinds of resources noticed and how to manage them in not more than 10 slides in groups of 5.

²² Source: <http://terra-agro.com/Company/bhj/images/wasteland1.jpg>

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Chapter 2 - Land Resource Management

Introduction

Land resources structure the most significant regular abundance of the nation and their legitimate use involves most extreme worry to its kin. The use of the land as indicated by its utilization capacity guarantees that this resource is used to the best favourable position. Its ill-advised use prompts wastage and can prompt dynamic degradation and loss of profitability of this indispensable resource. It is the ethical commitment of the present age to pass this important resource on to future ages as about healthy and over-misused as would be prudent, calligraphically. One of the most critical highlights of land use in India is the huge extent of territory reasonable for agribusiness that as of now has been brought under development. Around 11 percent of the surface zone is comprised of mountain land more than 7,000 ft. in height practically which is all excessively steep or excessively cold or farming. Another 18 percent of the surface is slope land somewhere in the range of 1,000 and 7,000 ft. above ocean level, there quarters of which is too steep to even think about farming. Levels of generally low help, somewhere in the range of 1,000 and 3,000 ft. structure 28 percent of all land in India, everything except a fourth is geographically usable. In the swamps, under 1,000 ft. in rise, which make up 43 percent of the complete territory in India, just a single section of land in 20 is unusable on account of unpleasantness of geography.

Land resources mean the resources accessible from the land, in this way the agrarian land which contains common manure for development of the items planted; the underground water, the different minerals like coal, bauxite, gold and other crude materials. The more a nation can find and utilize the crude materials, the more the industrialization of that nation, zone and so forth. Land resource alludes to the land accessible for abuse, as non-farming grounds for structures, creating townships etc. Land resources (characteristic resources) (monetarily alluded to as land or crude materials) happen normally inside situations that exist generally undisturbed by humankind, in a characteristic structure. Characteristic resources, with regards to "land" as characterized above, are taken to be those parts of land units that are of direct financial use for human population gatherings living in the region, or expected to move into the territory: close surface climatic conditions; soil and landscape conditions; freshwater conditions; and vegetation and creature conditions to the extent that they give produce. To a huge degree, these resources can be measured in financial terms. This should be possible regardless of their area (characteristic worth) or in connection to their closeness to human settlements (situational esteem).

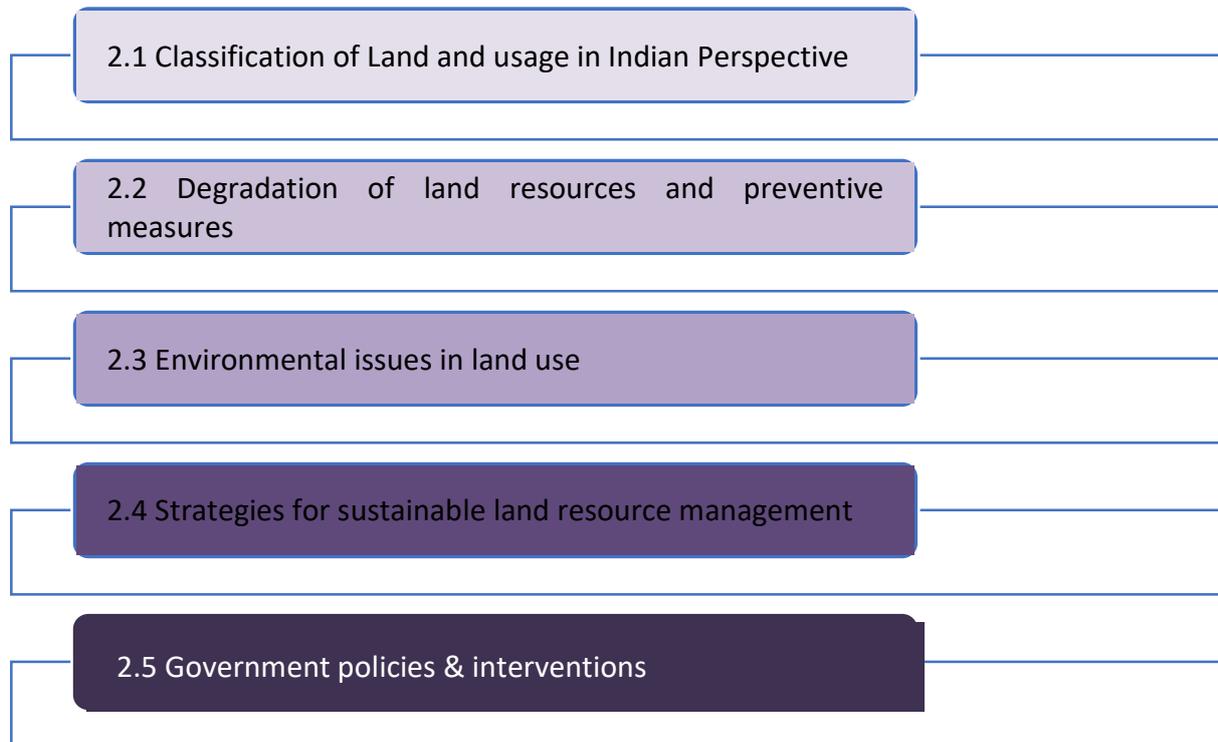
Environmental resources are taken to be those components of the land that have an intrinsic value of their own, or are of value for the longer-term sustainability of the use of the land by human populations, either in loco or regional and global. They include biodiversity of plant and animal populations; scenic, educational or research value of landscapes; protective value of vegetation in relation to soil and water resources either in loco or downstream; the functions of the vegetation as a regulator of the local and regional climate and of the composition of the atmosphere; water and soil conditions as regulators of nutrient cycles: Carbon cycle, Nitrogen cycle, Phosphorus cycle, Potassium, Sulphur (C, N, P, K, S), as influencing human health and as a long-term buffer against extreme weather events; occurrence of vectors of human or animal diseases (mosquitoes, tsetse flies, black flies, etc.).

Land is a major resource for agricultural development worldwide. The components of the natural land unit can be termed land resources, including physical, bionic, environmental, infrastructural, social and economic components, in as much as they are fixed to the land unit. Land, a critically important national resource, supports all living organisms including plants as well as every primary production system such as roads, industries, communication and storage for surface and ground water, among others.

Objectives

- To familiarise the classification of land and usage in Indian perspective
- To comprehend on degradation of land resources and its preventive measures
- To provide insights on environmental issues in land use
- To familiarise strategies for sustainable land resource management
- To provide insights on government policies and interventions

Chapter Structure



2.1 Land Use Patterns in India (new and traditional means)

Types of Land and its Utilization

Arrangement of land is "a procedure which relegates each body or tract of land in a region to its appropriate class in an arrangement of classes. The classes in the frameworks are characterized regarding the characteristics or attributes with which the characterization is worried." In India, the order of land has had its underlying foundations in farming statistics. Till 1950, the land in India was extensively arranged into five classifications –

- a. Area under forests
- b. Area not available for cultivation
- c. Uncultivated lands including current fallows
- d. Area under current fallows; and
- e. Net area sown.

Be that as it may, at that point it was understood that such a grouping didn't give an unmistakable image of the real region under various classes of land utilize required for farming arranging. Henceforth, a renaming was embraced from March 1950. Under it, land in India is presently grouped under nine distinct classes, viz.-

- a. Forests
- b. Barren and uncultivable lands
- c. Land put to non-agricultural uses
- d. Culturable wastes

- e. Permanent pastures and other grazing lands
- f. Miscellaneous tree crops and groves not included in the net area sown;

The complete geological zone of India is 328.88 million hectares; however, land utilize measurements are accessible for 304.1 m. hectares or 93.6 percent of the all-out topographical territory. The net territory planted is 138.3 m. hectares (or 44.7 percent) of which just 25.5 m. hectares or about 8.1 percent bear crop more than once. 52.8 percent of the land zone is under harvests and neglected. It implies that among huge countries of the globe, India is outstanding amongst other supplied with farming area. No man's land, land under urban or town settlement, and land put to other non-farming uses contain 14.3 percent of the absolute territory; woods land makes up another 22.0 percent. The rest of percent is comprised of town fields and eating area, and kindling forests, forest clean and bamboo, private rests and culturable waste.

Item	(Percentage of reporting area)	
	1950-51	1998-99
1. Area under forests	14.2	22.5
2. Area not available for cultivation	16.7	13.7
(i) Area under non-agricultural uses	3.3	7.3
(ii) Barren and unculturable land	13.4	6.4
3. Other uncultivated land (excluding fallow land)	17.4	9.4
(i) Permanent pastures and other grazing land	2.3	3.6
(ii) Land under misc. Free crops and groves not including in net area sown	7.0	1.2
(iii) Culturalable waste land	8.1	4.6
4. Fallow Land	9.9	7.6
Fallow land other than current fallows	6.1	3.2
Current fallow	3.8	4.4
5. Net area sown	41.8	46.6
6. Total cropped area	46.4	62.7
7. Area sown more than once	7.1	160.3
8. Cropping intensity*	111.1	135.0
9. Total reporting area	100.0	100.0
10. Area for which no return exists	13.5	7.4
11. Total geographical area (Million hect)	328.8	328.8

* Cropping intensity = (Total Cropped Area/net sown area) × 100

Fig 2.1 – Cropping Intensity in types of Land²³

Inside the all-out topographical territory, it is the arable land region which is of specific significance in an agrarian nation like India. For every one of the nations of the world 32 percent of the all-out geological region falls under this class. The comparing Exhibit of India is bigger at 46.3 percent. In USSR, it is 27.4 percent; in USA 40.0 percent; in Canada 6.4 percent and in Brazil 16.1 percent individually. The comparing Exhibit for the U. K. also, West Germany is 7; for Belgium, it is 11, for the Netherlands it is 14 and for Japan the Exhibit is 17; i.e., around multiple times as huge as that of India. In this way, while India is exceptionally populated, the arable land accessible in connection to the population is greatly improved than in nations like U. K., West Germany and Japan. In any case, the per capita cultivable land accessible in India is just 0.27 hectares as against 0.90 hectares in U. S. A., 0.92 hectares in USSR, 1.01 hectares in Argentina, 1.95 hectares in Canada and 3.40 hectares in

²³ Source - <http://www.geographynotes.com/essay/land-resources/essay-on-land-resources-india-geography/8193>

Australia. There has been a colossal increment in population with the outcome that the all-out land per capita as well as the extent of developed land per capita has been relentlessly shrivelling. The per capita developed land went down from 1.09 sections of land (0.44 hectares) in 1921, to 1.04 sections of land (0.42 hectares) in 1931, to 0.94 sections of land (0.34 hectares) in 1941, to 0.84 sections of land (0.34 hectares) in 1951, to 0.74 sections of land (0.30 hectares) in 1961; and to 0.27 hectares in 1971, with this decrease in the developed land per capita, the portion of nourishment and other produce of development accessible to every individual is declining.

Item	(Million Hectares)	
	1950-51	1998-99
1. Area under forests	40.5	69.0
2. Area not available for cultivation	47.6	42.4
(i) Area under non-agricultural uses	9.4	22.8
(ii) Barren and uncultivable land	38.2	19.6
3. Other uncultivated land (excluding fallow land)	49.4	28.7
(i) Permanent pastures and other grazing land	6.7	11.1
(ii) Land under misc. Free crops and groves not including in net area sown	19.8	3.6
(iii) Culturable waste land	22.9	14.0
4. Fallow Land	28.1	24.4
(i) Fallow land other than current fallows	17.4	9.9
(ii) Current fallow	10.7	13.5
5. Net area sown	118.7	142.6
6. Total cropped area	131.9	192.6
7. Area sown more than once	13.1	50.0
8. Cropping intensity*	111.1	135.1
9. Total reporting area	284.3	306.0
10. Area for which no return exists	44.4	22.8
11. Total geographical area	328.8	328.8

* Cropping intensity = (Total Cropped Area/net sown area) × 100

Fig 2.2 – Classification of Land Use in the country²⁴

The population thickness per hectare of gross territory planted differs significantly from 7.7 in Kerala, 5.7 in West Bengal, 5 in Tamil Nadu to 1.8 in M. P., 2.2 in Maharashtra, 2 in Punjab, 4.2 in Bihar, 3.5 in U. P. also, 1.5 in Rajasthan, all India normal being 3. The population thickness per hectare of gross region planted is higher in about a large portion of the states than All-India premise in Gujarat, M. P., Maharashtra, Karnataka, Punjab and Rajasthan, the population thickness is lower than All-India normal. Andhra Pradesh and Orissa have a similar thickness as All-India. On the off chance that the developed zone per capita is processed the circumstance stays comparable. The developed region per capita differs from 0.14 hectares in West Bengal to 0.11 hectares in Kerala, 0.17 hectares in Assam, 0.21 hectares in U. P., 0.31 hectares in Orissa, 0.3 hectares in Punjab, 0.68 hectares in Rajasthan, 0.41 hectares each in Maharashtra and Karnataka, 0.19 hectares in Tamil Nadu and 0.48 hectares in M. P. With the expansion in population the net region demonstrated has expanded during the year 1950-51 to 1982-83 by about 23.1 million hectares, i.e., the net developed zone expanded from 118.7 million hectares to 141.8 million hectares. This expansion has been because of expanded offices of water system, decrease in neglected terrains, and improved strategies for development, other than extension in different trimming, utilization of better strains of seed and the recovery of land for farming purposes.

²⁴ Source - <http://www.geographynotes.com/essay/land-resources/essay-on-land-resources-india-geography/8193>

Cultivated Land Areas

Cultivation in India is generally bound to Tamil Nadu, Gujarat, Maharashtra, West Bengal, U. P., Punjab, Bihar, Orissa, M. P., Haryana and Kerala. About 14.3 percent of the complete trimmed territory of the nation is in U. P. The second most noteworthy level of farming region is in Maharashtra (12.3 percent) trailed by M. P. (11.9 percent) Rajasthan (9.6 percent). Andhra Pradesh (8.3 percent), Bihar (7.2 percent), Karnataka (6.9 percent), Punjab, (6.5 percent), and Haryana (6.5 percent), Gujarat (5.3 percent), Tamil Nadu (4.7 percent), West Bengal (4.2 percent) and Assam (1.8 percent). The level of planted territory to add up to land zone fluctuates between various pieces of the nation and is fundamentally controlled by physical state of geography, soil and atmosphere. The Indo-Gangetic plain and the beach front fields record the most elevated rates, from 80 to 90, under development. The extent is significantly low in hilly or dry locales i.e., 10 percent or even lower. The conditions of West Bengal, Bihar, U. P. what's more, Orissa together record for around 33 percent of the net region planted in the nation however they structure 27 percent of the all-out land zone. The extent of planted territory fluctuates in these states somewhere in the range of 70 and 89, and might be considerably higher if the uneven and rocky areas are incorporated.

Table 2.1 Trends in Cultivated area(in million hectares)²⁵

Year	Net Sown Area	Gross Sown Area	Double Cropped Area	Cropping Intensity
1950-51	118.7	131.9	13.2	111.1
1960-61	133.2	152.8	19.6	114.7
1970-71	140.8	165.8	25.0	117.8
1980-81	142.3	175.1	32.8	123.4
1998-99	142.6	192.6	50.0	135.1

With a quick increment in population, the all-out level of cultivable region to the complete announcing region has now arrived at the wonderful Exhibit of 81 percent in Haryana to 56 percent in Kerala. The individual rate for different States is:Tamil Nadu 47, Gujarat 51, Orissa 39, Punjab 81, West Bengal 63, Bihar 49 and U. P. 58. Experts talking about the conditions in the Ganga valley see that, the densities of development and population in numerous areas of the Ganga plain are remarkable backwoods, glades, and swamps all are currently attacked by the furrow because of population increment, which additionally prompts shortage of feed and brushing ground.

The extent of trimmed zone to the all-out territory in the States of Peninsular India are a lot of lower than in the fields and fluctuate from 30 to 50 percent. In M. P., Karnataka, Tamil Nadu and Andhra Pradesh the level of trimmed land is 41, 54, 47 and 43 separately. In the bumpy territories and zones, the ground under harvest is very low, running from 10 to 20 percent of the land zone. For instance, it is just 11 percent in H.P., 16 percent in J. also, K., 7 percent in Meghalaya and Nagaland each, and 8 percent in Manipur. The level of planted zone more than once is more noteworthy in these States than in most other, running from 22 percent in Bihar to 23 percent in West Bengal and 24 percent in U. P., and more than 42 percent in Punjab, when contrasted with the normal of 11 percent for the entire nation. The huge reality achieved by the size of the absolute developed territory is the low level of region planted more than once. The constraining element is to be found in the inadequacy of dampness and deficient use of composts and manures. Twofold trimming is for the most part embraced where water is accessible either through downpours or by water system. In the eastern waterfront districts, twofold editing is made conceivable by the predominance of appropriate temperature and precipitation from the withdrawing rainstorm. Territory planted more

²⁵ Source - <http://www.geographynotes.com/essay/land-resources/essay-on-land-resources-india-geography/8193>

than once has expanded from 13.2 m. hectares in 1950-51 to 25.5 m. hectares in 1974-75, i.e., from 5.2 percent of the revealed region to 8.5 percent.

Land not Available for Cultivation

Of the absolute topographical territory, 41.24 million hectares are not accessible for development. Such zones comprise of land put to non-horticultural uses and infertile and uncultivable waste. Of this hectare, 34.8 percent comprises of the previous and 65.2 percent of the last kind of land. Land put to non-agrarian uses represents land involved by structures, streets, and railroads, or submerged e.g., streams trenches and different grounds put to utilize other than farming. M. P. has 10 percent of the complete land put to non-horticultural employments. The rates for U. P. are 12, Tamil Nadu 17, Karnataka 12 and Orissa 13. The fruitless land covers all infertile and uncultivable grounds like mountains, slopes, deserts and slope slants i.e., all land which can't be brought under development aside from at a significant expense is classed as uncultivable—regardless of whether such land lies in separated squares or inside developed possessions. Huge territories of such land existing in Assam (38 percent of the State), Gujarat (30 percent), Rajasthan (20 percent), Orissa (18 percent) and Manipur (64 percent). In any case, in Kerala, Tamil Nadu, Karnataka and Maharashtra such territories are little. The facts may demonstrate that entire of this land may not be fit for development or afforestation; however on the off chance that trees of various kinds, appropriate for various soils, are chosen, a huge extent of these grounds can be put under fuel and grain trees, and fields. During the arranging time frame a portion of the desolate land has been brought under development. It is evaluated that 4,124 million hectares of land was not accessible for development in 1988-89. It was 13.6 percent of the all-out land region. Region not accessible for development was 50.75 million of every 1960-61. Weight of population and development of monetary exercises are pulling the infertile land under development.

Territories Difficult for Cultivation

The territories where development of land is troublesome are:

- a. Eastern Maharashtra and the Madhya Pradesh where good countries are commonly fruitless aside from the dark cotton soil zones;
- b. Assam's unfortunate atmosphere in a few locales just as thick woodlands and mountains limit development to unequivocal regions;
- c. The Himalaya, where uneven nature of the land counteracts enormous development;
- d. Rajasthan, a dry locale which is in the west due to Thar desert, and in south because of uneven tract where absence of water supply development is very troublesome;
- e. Orissa, where jungle fever is exceptionally common;
- f. Madhya Pradesh, huge pieces of which are pervaded with Kans weed; and
- g. The entire nation in the south between Western Ghats and the ocean ports from Goa to Cannanore, which however wealthy in business crops and appreciate great precipitation, is at present in reverse because of undesirable atmosphere, predominance of intestinal sickness, deficiency of correspondence and shortage of work. On the off chance that these conditions can be improved, Malnad may contribute significantly towards raising farming creation.

It has been assessed that out of around 5 m. hectares of no man's land, 33% of the territory is harmed by water-logging and soil saltiness; another third is influenced by saltiness and alkalinity with low sub-soil water table, and the equalization of the region is compromised by the water-table ascending to under 25 cm from the surface. These require recovery measures. There can be no better proof of the present backwardness of rural creation in India than the way that 9.1 m. hectares of land is returned as present neglected terrains. This class of land include trimmed territories which are kept decrepit as a piece of the typical yield revolution during the present year. The territories of current fallows extend from 2 m. hectares each in Andhra to 1.2 m. hectares in Rajasthan and

around 1 m. hectares in Tamil Nadu, Maharashtra and Karnataka. A subsistence sort of generation normally includes a beneficial resource convincing the farmer to develop nourishment in a wide range of soil as a method of living and to endeavour to monitor ripeness of the dirt by the act of fallowing.

Miscellaneous: Additional Reading

Conceivable outcomes of Extension of Cultivated Area:

The complete land territory per capita in India comes to 2.2 sections of land (or 225 penny) as against 30 sections of land in USSR; 12 sections of land in USA, 6 sections of land in Indonesia, 5 sections of land in China and 3 sections of land in France. Of the complete per capita zone, loads of territories are usable. Based on the Pearson and Harper's equation that 95 percent of the mountains, 75 percent of the slopes, 25 percent of the levels and 5 percent, of the fields are usable, just 1.51 section of land per capita is left which can be named as geologically usable. Or then again, as it were, just 4.3; 37.7; 168.6 and 293.7 m. sections of land—an aggregate of 504 m. sections of land (out of 86.9 sections of land of mountains, 150.9 m. sections of land of slopes, 224.8 sections of land of levels and 349.9 m. sections of land of fields of land is geologically usable. Entire of this land isn't fit for Agriculture since it incorporates the sandy misuse of Rajasthan dry territory, Rann of Kutch and comparative land in north western and Western India totalling about 45.5 m. sections of land). Barring this kind of zone just 1.40 section of land per capita is left which ought to be considered as geographically usable.

Entire of this territory can't be viewed as extremely arable on the grounds that a significant segment of it is under town and town locales, streets, and conduits and so on. Further, sandy soils are underneath the base level of agrarian efficiency. Subsequent to offering lenient gestures of all these, solitary 0.97 section of land per capita are left which can be viewed as Arabic. Potential outcomes of augmentation are by all accounts not splendid. Anyway, it might be called attention to that the developed zone is about 46.0 percent of the all-out land zone and 72.6 percent of the most extreme conceivable farming territory. These proportions of developed zone are lower than the relating All-India proportions in Assam; M. P., Orissa, Rajasthan, and Himachal Pradesh. Be that as it may, in Punjab, West Bengal, Maharashtra, Bihar and Delhi, the proportion of such zone is incredible; while U. P., Andhra Pradesh, Kerala, Tamil Nadu and Karnataka remain in the middle of where the most extreme possibly is somewhere in the range of 20 and 25 percent of the social territory. This demonstrates the degree for augmentation is to some degree bigger in certain states and smaller in others. Almost certainly enormous zones in Sundarbans, Tarai, Western Rajasthan and significant pieces of the Deccan have huge territories of no man's land accessible for development yet the principle trouble is that of waste in certain regions, of thick woods in others and unfortunate atmosphere in yet others, other than impediments of water system, soil and geology. A few million hectares of land is pervaded by mosquitoes and jungle fever. This region can be made horticulturally fit by making it intestinal sickness free. The rice developing zones in India are correspondent with endemic malarial tracts and are uncultivated however rich. Such tracts are-(i) a level piece of the sub-Himalayan tract, Tarai, (ii) a vertical strip along the Eastern Ghats growing into a wide belt at the top converging into Tamil Nadu, Orissa, M. P. also, Andhra Pradesh.

In every one of these zones rice development might be entirely beneficial as the precipitation is between 76 cm to 250 cm every year. Jungle fever influences man however not the dirt. Mosquitoes and rice plants are both underwater. One is sea-going fauna and the other is amphibian vegetation. They develop under similar states of high temperature, high dampness and substantial precipitation. It is conceivable to control mosquitoes and stifle jungle fever and to develop more rice to nourish the nation. Therefore, as a long-haul program and endeavours ought to be made to expand the generation of rice by controlling intestinal sickness. The discoveries of the Wasteland Survey and

Reclamation Committee demonstrates that just around 2 million sections of land of no man's land can be brought under development and that too at a restrictive expense.

To summarize, it creates the impression that 50 percent of the all-out geological zone is either under harvests or is neglected. By all appearances, it might show up from this that it is conceivable, at the appointed time, to expand development over the other 50 percent of the land. This isn't so. Effectively around 20 percent of the all-out topographical territories is under woods; the need truth be told, is to degree this extent to around 33 percent. About another 10 percent would be taken up by human settlements, mines, railroad lines, streets, streams, mountains, and so forth. In this way, while some development of the territory under development—state from 50 percent to 60 percent of the land region—may be conceivable in the coming decades, the fundamental accentuation would need to be on expanding the per hectare yields, i.e., dependence should be put on strengthening of Agriculture and expanding efficiency per hectare on the present cultivable zone. Advancement of half-breed seeds and more noteworthy utilization of substance manures alongside land improvement measures by recovery of gorges, saline and dry grounds, levelling and bunding by guaranteeing better seepage, by taking different proportions of soil preservation and by improving the compound and natural nature of soil.

2.2 Challenges Associated with Land Resources & Preventive Measures

Land degradation is defined as the long-haul loss of environment capacity and efficiency brought about by unsettling influences from which the land can't recoup independent. Land degradation happens gradually and aggregately and has enduring effects on rustic individuals who become expanding powerless. Land degradation is a composite term; it has no single promptly recognizable element, yet portrays how at least one of the land resources (soil, water, vegetation, rocks, air, atmosphere, alleviation) has changed for the more terrible. An avalanche is regularly seen for instance of land degradation in real life – it changes the highlights of the land, causes obliteration of houses, and disturbs exercises. In the more extended term, be that as it may, the zone of an avalanche may recapture its profitability.

Thus, land degradation is a long way from being a straightforward procedure, with clear results. This unpredictability should be increased in value by the field assessor, before any endeavour is made either to characterize land degradation or to quantify it. Land degradation by and large implies the brief or perpetual decrease in the gainful limit of the land (UN/FAO definition). Another definition depicts it as, "the total reduction of the profitable capability of the land, including its significant employments (downpour encouraged, arable, inundated, rangeland and woods), its cultivating frameworks (for example smallholder subsistence) and its incentive as a financial resource." This connection between degradation (which is regularly brought about via land use rehearses) furthermore, its impact ashore use is key to about all distributed meanings of land degradation. The accentuation ashore, instead of soil, widens the centre to incorporate characteristic resources, for example, atmosphere, water, landforms and vegetation. The efficiency of meadow and timberland resources, notwithstanding that of cropland, is typified in this definition. Different definitions separate among reversible and irreversible land degradation. While the terms are utilized here, the level of reversibility isn't an especially valuable measure – given adequate time all degradation can be switched, as represented by the avalanche model above. In this way, reversibility relies on whose viewpoint is being evaluated and what timescale is imagined. While soil degradation is perceived as a significant part of land degradation, other forms which influence the gainful limit of cropland, rangeland and backwoods, for example, bringing down of the water table and deforestation, are caught by the idea of land degradation. Land degradation is, in any case, hard to get a handle on in its totality.

The "profitable limit of land" can't be evaluated basically by any single measure. In this manner, we need to utilize markers of land degradation. Markers are factors which may demonstrate that land degradation has occurred – they are not really the real degradation itself. The heaping up of dregs against a down slope obstruction might be a 'marker' that land degradation is happening upslope. Thus, decrease in yields of a harvest might be a marker that dirt quality has changed, which thusly may demonstrate that dirt what's more, land degradation is additionally happening. The state of the dirt is truly outstanding pointers of land degradation. The dirt coordinates an assortment of significant procedures including vegetation development, overland progression of water, invasion, land use and land the executives. Soil degradation is, in itself, a pointer of land degradation. Be that as it may, in the field, further factors are utilized as pointers of the event of soil degradation.

Mechanisms that Cause Land Degradation

1. **Physical processes:** Decrease in soil structure prompting crusting, compaction, degradation, desertification, ecological contamination and unsustainable utilization of regular resources.
2. **Chemical processes:** Acidification, Fermentation, draining, decline in inscriptions maintenance limit and loss of supplements.
3. **Biological processes:** Decrease altogether and biomass carbon and decrease in land biodiversity.

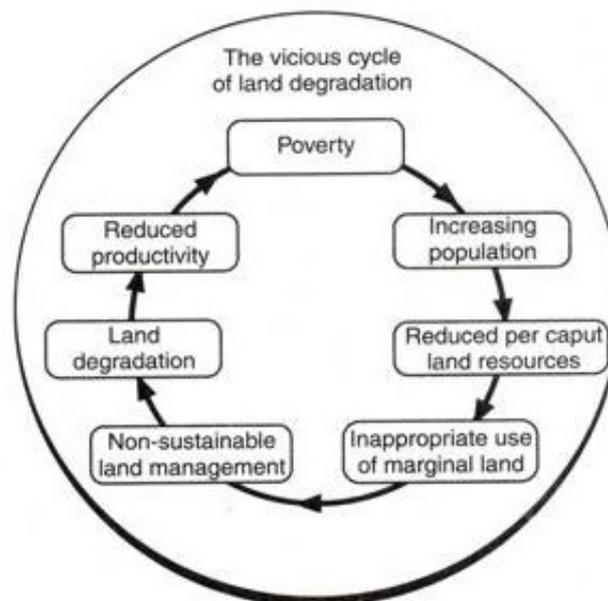


Fig 2.3 – The cycle of Land Degradation.

Primary Driver of Land Degradation

In spite of the fact that degradation procedures do happen without obstruction by man, these are comprehensively at a rate which is in offset with the pace of common recovery. Along these lines, for instance, water degradation under common backwoods relates with the subsoil development rate. Quickened land degradation is most normally caused as a consequence of human intercession in the condition. The impacts of this intercession are controlled by the regular scene. The most as often as possible perceived primary driver of land degradation incorporates:

- (i) Intensive water system prompts water logging and salinization, on which harvests can't develop.
- (ii) The utilization of an ever-increasing number of compound manures harms the dirt so that in the end the land winds up ineffective.
- (iii) The foundations of trees and grasses tie the dirt and soil. In the event that backwoods are exhausted, or prairies overgrazed, the land winds up ineffective and no man's land is framed.

- (iv) Land is additionally changed over into a non-inexhaustible resource when exceptionally lethal modern and atomic squanders are dumped on it.
- (v) Land degradation/soil degradation because of deforestation is progressively clear on soak slope inclines in the Himalayas and in the Western Ghats. These regions are called 'naturally delicate zones' or ESAs. To forestall the loss of a huge number of huge amounts of significant soil each year, it is basic to save what survives from our regular woods spread. It is similarly imperative to reforest stripped zones. The linkage between the presence of woods and the nearness of soil is more prominent than the timberland's physical soil restricting capacity alone. The dirt is improved by the leaf litter of the woodland. It is separated by soil miniaturized scale living beings, organisms, worms and bugs, which help to reuse supplements in the framework. Further misfortunes of our soil's riches will devastate our nation and lessen its ability to develop enough nourishment in future.
- (vi) The pace of mangrove misfortune is essentially higher than the loss of some other sorts of woods. On the off chance that deforestation of mangroves proceeds, it can prompt extreme misfortunes of biodiversity and employments, notwithstanding salt interruption in seaside zones and siltation of coral reefs, ports and sending paths.

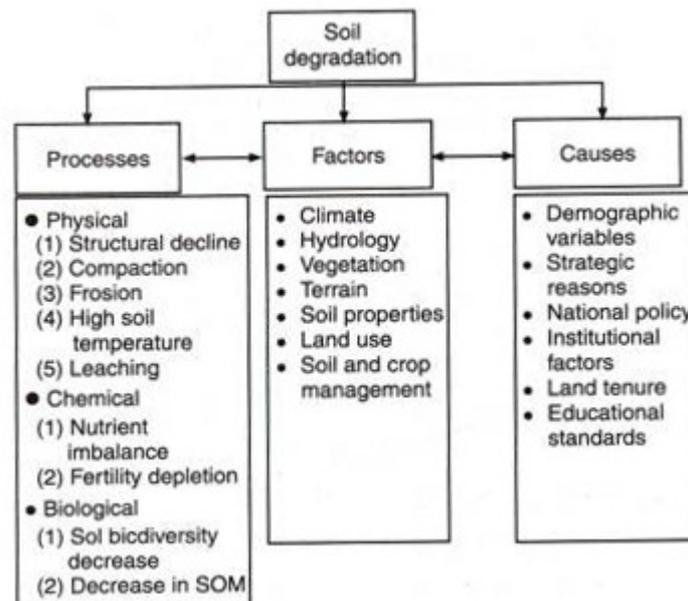


Fig 2.4 Soil Degradation Flow-chart.

Inside these general classes a wide assortment of individual causes is fused. These causes may incorporate the transformation of inadmissible, low potential land to farming, the inability to embrace soil saving measures in zones in danger of degradation and the evacuation of all harvest deposits bringing about 'soil mining' (for example extraction of supplements at a rate more noteworthy than resupply). They are encompassed by social and financial conditions that energize land clients to overgraze, over-develop, deforest or on the other hand dirty. It is conceivable to recognize two sorts of land degradation activities.

The first is unsustainable land use. This alludes to a framework of land utilize that is completely improper for a specific condition. It is unsustainable in the feeling that, except if amended this land use or for sure something other could not be advanced into. Un-sustainability has the suggestion of being irreversibly debasing. Numerous 'barren wasteland' (very uncovered, de-vegetated and disintegrated inclines) are successfully irreversible. Be that as it may, a huge contribution of innovation could start a restoration procedure, if sufficient opportunity also, resources were to be dedicated. As a rule, this is uneconomic. The impact of a land degradation procedure contrasts contingent upon the natural attributes of the land, explicitly soil type, incline, vegetation. In this manner an action that, in one spot, isn't debasing may, in somewhere else, because land

degradation due to various soils attributes like geology, climatic conditions or on the other hand different conditions. Along these lines, similarly erosive rainstorms happening above various soil types will bring about various paces of soil misfortune. It pursues that the basket of the reasons for land degradation must perceive the collaborations between various components in the scene which influence degradation and furthermore the site-particularity of degradation.

Farmers' Concerns

A differentiation is made between profitability, which is characterized as the innate capability of a land framework to deliver harvest yields, and creation, which is characterized as the real yield levels accomplished by farmers. Land degradation may diminish the inborn profitability of a framework; however, generation levels might be unaffected, or may increment because of repaying move being made by the land client (for instance, the utilization of manure). Land the executives practices may not misuse the maximum capacity profitability of the land. Land degradation, whenever characterized as a misfortune in profitability, is firmly lined up with the interests of farmers, whose significant concern is the yield that they can accomplish from their territories. Albeit current reap potential is basic to most cultivating choices, farmers will regularly take a long-haul way to deal with land efficiency. Cultivating exercises can trigger or fuel land degradation, hiding away future issues for land clients.

Sensitivity and Resilience are other aspects with reference to Land degradation that must be taken into account in the discussion. These two terms are synonymous with Affectability and flexibility. Affectability and flexibility are proportions of the helplessness of a scene to degradation. These two variables consolidate to clarify the level of helplessness. Sensitivity is how much land framework experiences change because of common powers, human mediation or a blend of both. A few spots are bound to be delicate to change – for instance, soak inclines territories of extreme precipitation or profoundly erodible soils. These spots are dependent upon normal risks that make them delicate to change. Human intercession in these frameworks can bring about emotional modifications. Sensitivity to change can emerge because of human intercession – for instance, in a whiz state, forested slopes might be hard to degrade, but once converted to farmland degradation may occur more easily.

Resilience is the property that permits a land framework to ingest and use change, including protection from a stun. It alludes to the capacity of a framework to come back to its pre-changed state following change. The common Resilience of a condition might be improved by the assorted variety of the land the board practices embraced by land clients. Corrupted land is less versatile than un-degraded land. It is less ready to recuperate from further stuns, for example, dry season, prompting even further degradation.

		<i>Sensitivity</i>	
		<i>High</i>	<i>Low</i>
<i>Resilience</i>	<i>High</i>	Easy to degrade Easy to restore capability	Hard to degrade Easy to restore capability
	<i>Low</i>	Easy to degrade Difficult to restore capability	Hard to degrade Hard to restore capability

Fig 2.5- Resilience – Sensitivity Matrix²⁶

²⁶ Source – archive.unu.edu/env/plec/l-degrade/D-Ch_2.pdf

The Above Table outlines the connection between Resilience and Sensitivity of biological systems. Where a scene is vulnerable to change (high Sensitivity) the danger of degradation is influenced by the strength of that scene – high strength reduces the threat of genuine degradation, while low strength demonstrates that changes are not liable to be effectively reversible and may even be changeless. Land frameworks that display high versatility are probably going to come back to their past stable state following disturbance, while frameworks with low flexibility are bound to be for all time changed by such disturbance.

Advance acknowledgment of the Sensitivity and Resilience of a land framework should impact land use choices, in this way lessening the danger of changeless degradation to the framework. Thus, the Sensitivity and strength of explicit soil types additionally cautions the field assessor to the danger of perpetual or transitory soil degradation. For instance, an iron-rich however profoundly endured and corrosive Ferrosol of the damp tropics has a low Sensitivity to degradation just as low versatility. In this way, when it has been corrupted (which is hard to do in a physical sense), at that point it is practically difficult to take back to a gainful state. Balance this with a Phaeozem (dark soil with a high base status, but without a secondary carbonate within one metre of the soil surface) that has high natural issue furthermore, a fantastic structure. Under great the executives Phaeozems give reliably high yields, however with poor administration they corrupt quickly. This high affectability is directed to some degree by a high flexibility, since utilizing natural techniques the dirt can be restored decently fast.

	<i>Intensive Rainfall</i>	<i>Low SOM</i>	<i>Steep Slopes</i>	<i>Sodic Soils</i>	<i>Poor Management</i>	<i>Drought</i>	<i>Deforestation</i>	<i>Luvisol</i>	<i>Vertisol</i>
<i>Vertisol</i>	Low S Low R	Low S Low R	N/A	Mod S Low R	Low S Mod R	High S Low R	High S Low R	N/A	
<i>Luvisol</i>	High S High R	High S High R	High S Low R	N/A	High S High R	High S High R	High S Mod R		
<i>Deforestation</i>	High S High R	High S Mod R	High S Low R	High S Low R	High S Mod R	High S Mod R			
<i>Drought</i>	N/A	High S Low R	High S Low R	High S Low R	High S Mod R				
<i>Poor Management</i>	OF = S Low R	High S Mod R	High S Low R	High S Low R					
<i>Sodic Soils</i>	High S Low R	High S Low R	N/A						
<i>Steep Slopes</i>	High S Low R	High S Mod R							
<i>Low SOM</i>	High S High R								
<i>Intensive Rainfall</i>									

S = Sensitivity R = Resilience OF- Determined by combination of other factors
 SOM = Soil Organic Matter

Fig 2.6- Examples of How Resilience and Sensitivity are Affected by Different Factors²⁷

What Characteristics Contribute to Sensitivity and Resilience

The variables that influence affectability and strength of an environment are the innate attributes of that condition (for example soil properties, for example, supplement holds, soil structure, small scale

²⁷ Source – archive.unu.edu/env/plec/l-degrade/D-Ch_2.pdf

totals and soil profundity, geology, atmosphere and so on.), and the human component, as land use and the management practices. The notable highlights influencing Sensitivity & Resilience will differ here and there. Along these lines, as to parts of land degradation, affectability alludes to the fact that it is so natural to corrupt the land, and strength to the fact that it is so natural to re-establish the land. A few blends of elements that may impact the affectability and strength of land frameworks are proposed in fig 2.6.

The variables recorded in the lattice were chosen haphazardly. This matrix shows how unique blends of components influence the affectability what's more, versatility of a framework in various ways. For instance, the affectability of a Vertisol to escalated precipitation is low (for example difficult to corrupt), while when concentrated precipitation is joined with soak slants affectability, and the danger of degradation, is high. Additionally, poor the executives of soak slants is probably going to result in degradation which would be hard to turn around (for example low versatility), while an inadequately overseen Luvisol is profoundly versatile and consequently all the more simple to re-establish the vitality.

Levels of Analysis of Degradation

The assessment of field degradation at various scales sustains into various degrees of investigation. Each level has its own specific set of employments. The first and most prompt utilization of data identifying with existing or potential degradation is to distinguish the dangers at field and farm level. Mapping of fields and point by point site examination are included here. The following level is to rank the degrees of genuine degradation, or future danger of degradation, by reference to their earnestness. This enables the land client to organize potential reactions to degradation chance also, to target portions of the farm where hazard is most noteworthy. The field assessor may utilize this level of investigation to make semi-quantitative correlations among destinations and circumstances. A three degree of examination is to formalize the prioritization by farmers by appending financial qualities to the costs (time, work, cash) and to the advantages of any strategy (counting 'sitting idle'). They are as follows -

- i. **Mapping of fields:** The initial phase in surveying land degradation is to assess the visual proof of degradation in the territory under survey. The physical parts of the scene must be watched and assessed. Setting up a guide of the region under audit (farmer's field or homestead) will help to recognize regions at specific danger of degradation due to the normally happening includes in the scene. Talks with farmers will outfit significant data about yield and the life of plant development in various zones of the field. The site-explicit qualities distinguished at this stage help to distinguish where the most noteworthy dangers of land degradation exist in a field, farm or on the other hand over a bigger region. An efficient way to deal with mapping of the region under survey will distinguish existing degradation as well as will pinpoint regions in danger from future degradation. Since land degradation happens because of the consolidated impacts of soil attributes, slant edge, atmosphere and land the board, changes presented by the land director will influence the dangers of land degradation. The mapping of the zone under scrutiny means to recognize the reasons for degradation and to clarify why a few pieces of the zone under audit might be progressively powerless to degradation than others. Relatively more exertion might be required by the land client to ensure powerless territories from future degradation.
- ii. **Ranking dangers as indicated by reality:** Having mapped (in-field or on-farm) the real degradation happening and the potential for further degradation later on, the recognized dangers can be positioned dependent on their reality. It gives some direction on how this positioning can be completed, not exclusively to evaluate the dangers yet additionally to give an apparatus to help future basic leadership. This positioning leads into activity plans for fighting area degradation, permitting land clients to organize the focal point of their protection/land degradation anticipation exercises.

- iii. **Cost-advantage investigation:** The recognizable proof and positioning of the dangers of land degradation frames the information for further examination. It empowers farmers to gauge the expenses and advantages of measures and systems that will decrease or take out land degradation and to contrast these and the expenses and advantages of sitting idle. This sort of appraisal, known as money saving advantage examination, underlies the procedure of settling on choices about interest in land what's more, cultivating exercises in both smallholder and business Agriculture. Regardless of whether to put resources into a capital or work concentrated action will rely upon the apparent advantage of it to the individual making the speculation. This last point is significant – while financial aspects empowers us to do re-enacted money saving advantage examination for basic leadership purposes, at last the investigation is abstract depending on the qualities connected to explicit expenses and advantages by individual land clients. Thusly, two farmers living next to each other, with comparable homesteads as far as region, geography and richness may settle on broadly various choices about land the board issues, be it the harvest to be planted, the ripeness treatment to be attempted or on the other hand physical preservation measures to be burrowed. This subjectivity mirrors the conditions of the individual land client. Money saving advantage investigation must not be viewed as a prescriptive instrument. It can't be applied precisely to land at a solitary 'right answer'. Catching the expenses and advantages that are imperative to the individual is the most ideal method for drawing near to the 'right response' for that farmer.

<i>Scientific Interpretation</i>	<i>Ū Process</i>	<i>Land Users' Interpretation</i>
High erosivity and potential soil erosion	Heavy rainfall	Damage to crops. But also benefit to soil and planting opportunity.
Loss of finer soil particles through water or wind erosion	Stones on the soil surface	Soil formation (Burungee people, Dodoma region, Tanzania)
Increased risk of soil loss through water erosion	Planting crops up and down steep slopes rather than across	Protection of crop from waterlogging and/or wind damage
Severe erosion and abuse of catchment	Deep gullies	Livestock fatalities and loss of roads/bridges
Severe short term erosion, indicating need for better cover	Rills	Useful local drainage channels to prevent waterlogging and into which to place weeds
Soil and water conservation measure to trap soil and conserve water	Barriers across the slope intercepting soil	Convenient way to subdivide garden for planting and management purposes
Danger of erosion and need to instigate organic conservation measures to decrease erodibility	Erodible soils	Opportunity to harvest sediment at bottom of slope and create new field

Fig 2.7- Comparison of interpretations of land degradation²⁸

2.3 Environmental Issues in Land Use

The connection between land use and the atmosphere is perplexing. To start with, land spread - as formed via land use rehearses - influences the worldwide convergence of ozone depleting substances. Second, while land use change is a significant driver of environmental change, a changing atmosphere can prompt changes in land use and land spread. For instance, farmers may move from their standard harvests to crops that will have higher monetary return under changing

²⁸ Source - archive.unu.edu/env/plec/l-degrade/D-Ch_2.pdf

climatic conditions. Higher temperatures influence mountain snowpack and vegetation spread just as water required for water system. The comprehension of the collaborations among atmosphere and land use change is improving however proceeded with logical examination is required.

Land use pattern and common practices in an area often affect the environment in more ways than we can perceive. The land use in India is varied and area specific. The difference is in the type of activities that dominate in an area with respect to agricultural practices and crops sown and additionally the fate of dry and fallow lands. From practicing 'jhum' cultivation majorly practiced in the provinces of North east India has serious repercussions on the land in that area. It is commonly known as 'slash and burn' and 'hedge fallow' farming. It is differently named as Ladcmg in Indonesia, Caingin in Philippines, Milpa in Central America and Mexico, Ray in Vietnam, Conuco in Venezuela, Roca in Brazil, Masole in the Congo and Central Africa.

It is likewise drilled in the good countries of Manchuria, Korea and southwest China. It is known as Jhum or Jum in the sloping conditions of Northeast India, as Podu, Dabi, Koman or Bringa in Orissa, as Kumari in Western Ghats, as Watra in southeast Rajasthan, as Penda, Bewar or Dahia and Deppa or Kumari in the Bastar region of Madhya Pradesh. Clearing of forests is the essential of moving forward. The felling of trees and clearing of shrubberies, be that as it may, quicken soil degradation and accentuate inconstancy of precipitation which may lead either to dry seasons or floods. The general effect is the decrease in soil ripeness. The biological systems lose their versatility qualities. The populace subject to moving development faces the lack of nourishment, fuel wood and feed. Consequently, the wholesome standard goes down. These procedures culminate into the social poverty and ecological imbalance.

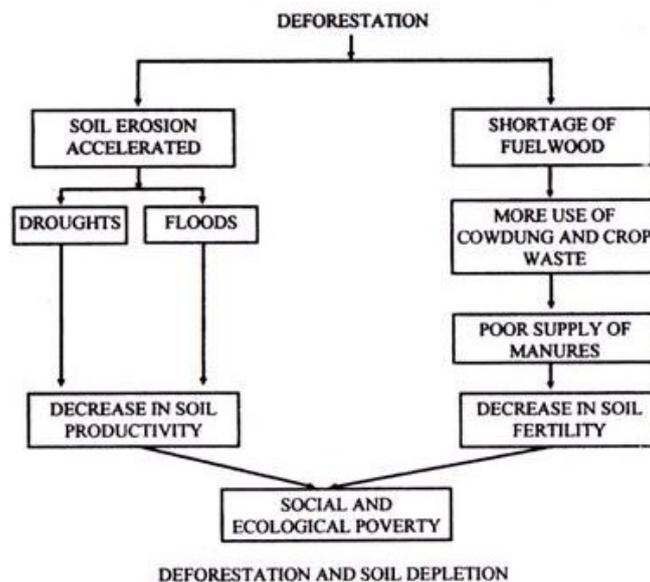


Fig 2.8: Deforestation as a fallout Land Use²⁹

The effect of moving development on biomass and soil degradation has likewise been appeared in Exhibit. From that point it might be seen that as the cycle of moving development ends up shorter, the biomass on which depends the humus of soil decays and the biodiversity is impressively decreased. The subsistence Agriculture vanishes and the generally solid cultivators start getting network land. They additionally start connecting with workers which conflicts with the range of their general public and method of life.

²⁹ Source -<http://www.yourarticlelibrary.com/essay/land-degradation-mechanisms-and-causes-of-land-degradation/30043>

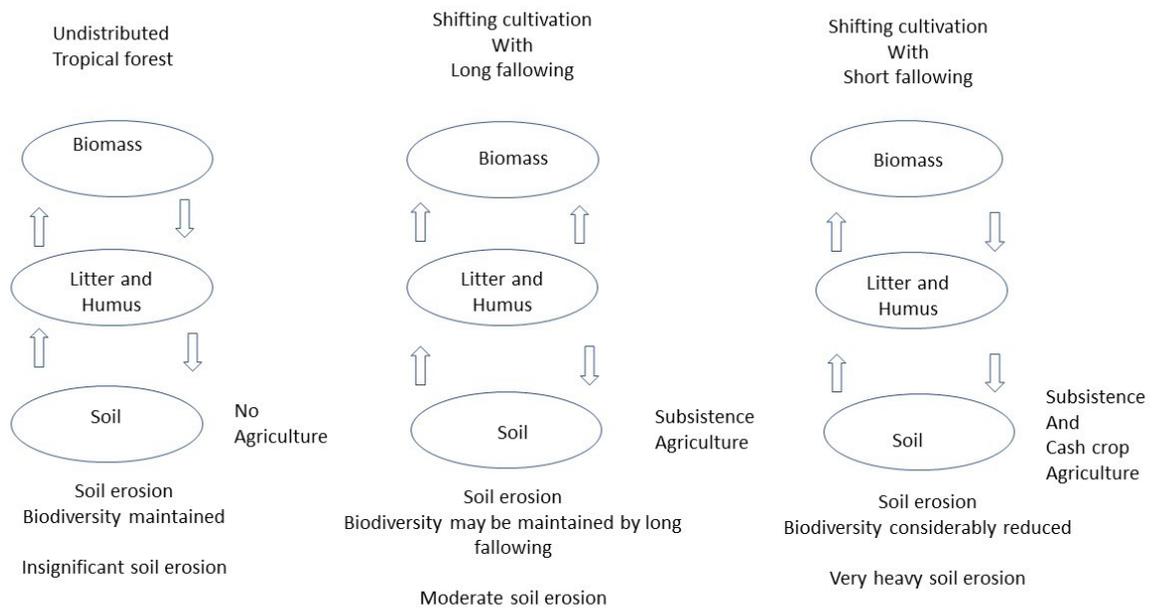


Fig 2.9: Shifting agriculture, biomass and Land Degradation³⁰

How does changing the use of land affect the environment?

The land use pattern has changed a lot. Conversion of backwoods into croplands and for building structures is most common. Removing trees is the most hazardous impact. Agriculture causes nitrogen, phosphorus, ammonia, pesticides and such to settle in soil and seas. The contamination causes innumerable outcomes. Mining rocks and expelling slope regions cause biodiversity misfortune just as other impacts. The joined impact is worldwide warming, climate change, natural catastrophes and terrible death toll and riches. The essential purpose behind land use change is to clear woodlands for farming and nourishment generation; for building residences for individuals in urban areas and towns; and improvement of mining and enterprises.

1. Deforestation for farming

At the point when woodland spread is evacuated, the dirt is presented to coordinate daylight, effects of overwhelming downpours and winds prompting serious soil disintegration, loss of biodiversity and important local species, loss of living spaces for untamed life, exhaustion of groundwater and other common resources, corruption of land and water resources, contamination of the earth by rural, modern, and creature and human squanders, and intrusion by creepy crawly bugs (e.g., mosquitoes) and pathogens in homes. Decreased yield efficiency, expanded soil/air/water contamination, expanded nursery outflows, an Earth-wide temperature boost and environmental change, and expanded recurrence of common cataclysms (dry season, flood, storms, and so on.) are for the most part because of concentrated mechanical cultivating of harvests and creatures for nourishment.

2. Advancement of Urban Communities and Related Framework

Advancement of urban communities and related framework including lodging is another type of land use change that can explicitly affect condition, contamination, water and vitality use, squander the executives. Associated and reduced urban communities are more effective and prudent than spread urban areas. The World Resources Institute, Washington, shows that:

³⁰ Source -<http://www.yourarticlelibrary.com/essay/land-degradation-mechanisms-and-causes-of-land-degradation/30043>

\$3 trillion worth of urban foundation speculations could be spared throughout the following 15 years if the world's biggest and quickest developing urban communities received associated and conservative as opposed to spread plans for urban communities. \$200 billion will be yearly investment funds that the United States could accomplish on the off chance that it sought after progressively minimal urban development. For instance, residents in rambling Houston spend around 14 percent of GDP on transport, contrasted and 4 percent in littler, more populace thick Copenhagen. Without a doubt, the financial and natural points of interest of smaller city configuration can be seen when contrasting Barcelona and Atlanta. The two urban communities house around 5 million individuals. In any case, while Atlanta experiences urban sprawl—covering in excess of 4,000 square kilometres—Barcelona received a smaller, 162-square kilometre structure. Atlanta heaves in excess of multiple times the measure of transport discharges as Barcelona.

3. Mining and ventures including force creating plants

Land use change through mining and improvement of businesses can explicitly affect condition, contamination, water and vitality use, squander age and transfer, loss of biodiversity and untamed life territories, etc.

4. Brief land use changes

Indeed, even brief land use changes such as assembling of a large number of individuals for unique events can cause serious changes in a zone and posture hardships to nearby networks. Traffic, commotion contamination, ground compaction (changeless effect), loss of vegetation, soil disintegration, strong waste (paper, plastic, nourishment), human waste, neighbourhood framework is altogether issuing of huge social affair of individuals in a spot. A portion of the key components that ought to be considered in such get-togethers are: squander the executives, carbon impression, vitality utilization and effects on bio decent variety.

2.4 Sustainable Land Management practices

What Is Sustainable Land Management?

Land gives a domain to Agricultural, horticultural and allied goods generation; however, it likewise is a basic condition for improved natural administration, including source/sink capacities for nursery gasses, reusing of supplements, enhancement and separating of toxins, and transmission and decontamination of water as a component of the hydrological cycle. The target of sustainable land management (SLM) is to orchestrate the complimentary objectives of giving natural, financial, and social open doors to serve present and who and what is to come, while keeping up and improving the nature of the land (soil, water and air) resource (Smyth and Dumanski, 1993). Feasible land is the utilization of land to meet changing human needs (agribusiness, ranger service, protection), while guaranteeing long haul financial and environmental elements of the land.

Sustainable land management is a fundamental structure that obstructs for economical farming advancement, and it is a key component in AGENDA 21's objective of maintainable improvement (Chapter 10). Feasible rural improvement, preservation of characteristic resources, and advancing maintainable land the executives are key destinations of the new World Bank rustic venture program, From Vision to Action (World Bank, 1997), and progressively these targets are being incorporated into all rural advancement and normal resources the board ventures.

- I. Economical land the board consolidates innovations, strategies, and exercises planned for coordinating financial standards with ecological concerns, in order to at the same time:
- II. keep up and improve creation (profitability)
- III. decrease the degree of creation hazard, and improve soil ability to cushion against debasement forms (soundness/flexibility)
- IV. ensure the capability of regular resources and forestall corruption of soil and water quality (assurance)

- V. be monetarily suitable (feasibility)
- VI. be socially adequate, and guarantee access to the advantages from improved

The definition and these criteria, called mainstays of SLM, are the essential standards and the establishment on which economical land the executives are being created. Any assessment of the maintainability must be founded on these destinations: profitability, dependability/flexibility, insurance, feasibility, and agreeableness/value (Smyth and Dumanski, 1993). The definition and columns had been field tried in a few nations, and they were made a decision to give helpful direction to evaluate maintainability.

The absence of an exhaustive, quantifiable definition for sustainable land management is now and then viewed as a genuine inadequacy. However, as contended by Gallopin (1995), an exploration model for supportability must be increasingly adaptable and along these lines less simple to measure than an examination model for science, material science, or traditional agronomy. Such an exploration model must be structured around an assessment procedure (instead of topical setting), since it is proposed to test the probability of specific occasions occurring and the total effects of these occasions, as opposed to points of interest of different invalid theory or the effects of specific data sources or land the executives intercessions. Basically, the examination model must incorporate an objective explanation, a reasonable system, a lot of methods, and criteria (markers) for determination. One of the primary destinations of such an examination model is to assess the effects of occasions which are unsure; however the procedure of assessment is guided by logically characterized conventions.

Principles and Criteria for Sustainable Land Management

Encounters picked up from field extends in creating and created nations has recognized a progression of standards (exercises learned) for reasonable land the board, and these can be utilized as general rules for improvement ventures (Dumanski, 1994; 1997; World Bank, 1997). The most helpful of these are outlined underneath:

Global Concerns for Sustainability

Manageability can be accomplished uniquely through the aggregate endeavours of those promptly answerable for overseeing resources. This requires an arrangement situation that enables farmers and other, nearby leaders, to receive rewards for good land use choices, yet in addition to be considered answerable for improper land employments. Coordination of financial and natural interests in an extensive way is important to accomplish the targets of supportable land the board. This necessitates ecological concerns be given equivalent significance to monetary execution in assessing the effects of advancement ventures, and that dependable pointers of natural execution be created.

There is pressing need to determine the worldwide test to deliver more nourishment to sustain quickly rising worldwide populaces, while simultaneously saving the natural creation potential, flexibility, and ecological support frameworks of the land. Supportable land the executives, if appropriately planned and actualized, will guarantee that farming turns into a piece of the ecological arrangement, as opposed to staying a natural issue.

Sustainable Agriculture

All the more biologically adjusted land the board can accomplish both monetary and natural advantages, and this must be the establishment for further provincial mediations (ventures). Without great land the board, different interests in the country area are probably going to be disappointing². Simultaneously, contending for the proceeded with upkeep of agribusiness without reference to natural supportability is progressively troublesome.

Agrarian strengthening is frequently important to accomplish increasingly feasible frameworks. This expects movements to higher worth generation, or more significant returns with more sources of info per unit of creation and better expectations of the executives (more information concentrated). Be that as it may, supportable agribusiness needs to work inside the limits of nature not against them. Many yield enhancements can be accomplished by upgrading productivity of outside sources of info as opposed to attempting to boost yields.

The significance of off-farm pay ought to not be thought little of in light of the fact that it i) supplements income on the homestead, ii) creates a speculation situation for improved land the executives, and in this way iii) decrease generation weights ashore.

Sharing Responsibility Regarding Sustainability

Farmers and land directors must extend their insight into reasonable innovations and actualize improved strategies of land stewardship. The favoured alternative isn't to instruct the farmer (order and control enactment), yet to make an empowering situation through approach intercessions where farmers are all the more allowed to settle on the correct decision. An approach domain where farmers are increasingly engaged, yet additionally considered responsible, for accomplishing the targets of feasible land the executives is basic. Nonetheless, feasible land the executives is the duty of all portions of society. Governments must guarantee that their strategies and projects don't make negative natural effects, and society needs to characterize necessities for land support and build up a "social" rebate rate for future land use choices that empowers the most economical use. Worries for supportable land the executives go past agribusiness to incorporate the genuine interests of different parts of land stewardship, including natural life, waterfowl and biodiversity the board. There is expanding proof that society is requesting that farmers become stewards of provincial scenes, and that Agriculture become more than just putting nourishment on the table. A large number of society's natural qualities may not speak to financial additions for farmers, in any case, and farmers can't bear every one of the expenses of ecological support.

Relationships among Soil Quality, Land Quality, and Sustainable Land Management

New ideas of soil and land quality are rising, and frequently these are utilized reciprocally. These ideas and their connections are condensed underneath, to the degree that some consensus is accessible on how this ought to be applied. Soil quality is the limit of a particular soil to work inside normal or oversaw biological system limits to continue plant and creature generation, keep up or upgrade water quality, and bolster human wellbeing and home (SSSA, 1994). Land quality is the condition, state or "wellbeing" of the land comparative with human necessities, including rural creation, ranger service, preservation, and ecological administration (Pieri, et al., 1995).

Supportable land the board joins innovations, arrangements, and exercises planned for coordinating financial standards with ecological concerns in order to at the same time keep up or upgrade generation, decrease the degree of creation hazard, secure the capability of regular resources and forestall (cushion against) soil and water debasement, be monetarily reasonable, and be socially satisfactory (Smyth and Dumanski, 1993). These ideas measure the sizes of details, applications, and levels of incorporation with financial information. Soil quality is the most prohibitive, trailed via land quality and after that reasonable land the board. Soil quality is viably a state of a site, and it tends to be examined utilizing soil information alone. Land quality requires joining of soil information with other biophysical data, for example, atmosphere, geography and land use. Land quality is a state of the scene, for example it is a biophysical property, however incorporates the effects of human intercessions (land use) on the scene. Supportable land the board requires the coordination of these biophysical conditions, for example land quality, with financial and social requests. It is an evaluation of the effects of human residence, and a state of manageable improvement.

How might we turn around such harms because of defective land use? (See fig 2.10)

1. Regenerative Preservation Agriculture

Preservation practices followed in customary cultivating included grassed channel strips, streamside vegetation, and windbreaks that diminish the development of pathogens, supplements, and pesticides into encompassing water bodies and onto seas, making natural surroundings for untamed life including pollinators and other useful creepy crawlies, and improving on-farm biodiversity planting various harvests in intercropping or blended editing or yield animal blended cultivating frameworks (see Fig.). Other protection practices included vegetable yields for nitrogen obsession, crop pivots, terracing and the utilization of assorted harvest assortments. Human, creature and yield squanders were deliberately reused to keep up soil richness (no-waste agriculture).



Fig 2.10: A schematic chart of protection cultivating [Source: National Sustainable Agriculture Coalition (NSAC)]

2. Security of Backwoods and Characteristic Vegetation

The security of backwoods and characteristic vegetation falls under various lawful systems as per whether land is in general society or private areas. On open grounds the fundamental instrument for the assurance of vegetation is the foundation of a system of ensured regions or stores (for example woodland and untamed life saves). On the private terrains, the administration can force some land use constraints so as to protect local vegetation in one form or other. Improving implementation of natural guideline inside private provincial landholdings is basic to expand timberland spread. Farmers can save a level of the territory by leaving them in homestead woodlands, or their local vegetation. The legislature can likewise force that the local vegetation in touchy zones, for example, on soak inclines and along the edges of waterways and streams be preserved as Areas of Permanent Protection.

3. Reforestation, Rebuilding of Debased Terrains and Watersheds, and Decrease of Nourishment Squanders

As indicated by World Resources Institute, Washington, rebuilding of corrupted terrains and reforestation and assurance of watersheds can have unmistakable positive effects as demonstrated as follows:

One-fourth of farming grounds are right now debased and less beneficial than they could be. Re-establishing only 12% of these (150 million hectares) into efficiency could sustain 200 million individuals by 2030, raise \$35-40 billion every year in farm livelihoods, reinforce atmosphere versatility, and decrease outflows.

\$170 billion will be the net advantages from watershed security, improved harvest yields, and woods items that could be understood every year by beginning the reclamation of 350 million hectares of lost or debased woodlands. This rebuilding could likewise sequester 1-3 billion tons of CO₂e every year.

\$200 billion every year could be spared by created nations by 2030 by decreasing nourishment squander, which would likewise lessen emanations.

4. Advancement of Reasonable Mining and Businesses

Businesses must receive rehearses that decreases contamination of air, water and soil; diminish all types of mechanical squanders and embrace safe waste transfer strategies, limit impacts on the earth; help spare woods, common vegetation, and biodiversity; energize tree planting, greening of urban communities, and reforestation in a joint effort with nearby networks; move away from petroleum product vitality to sustainable power source (sun based, wind) however much as could be expected. Organizations can make new business openings by receiving green innovations and feasible advancement. Some driving worldwide organizations are additionally observing the business openings related with more sustainable land use.

As the most significant common resource, practical utilization of land resource is the fundamental assurance of maintainable advancement. The idea of reasonable utilization of land resource is to hold the amount and profitability of land resource from age to age.

5. Sustainable Livestock Management

Good Livestock farming practices and animal wellbeing are indispensable for individuals living in more unfortunate nations. This down to earth learning manual is a reasonable guide for the individuals who are answerable for preparing ranchers in poor nations, considering customary cultivating frameworks, existing information sources and assets, feasible cultivating activities and prompting on the correct ways to deal with preparing. The general points are to improve the condition and soundness of animals in poor nations and the lives of the individuals in these nations. Prairies are one of the world's significant biological systems gatherings and in the course of the only remaining century their utilization has changed from being volunteer leys, or an asset on non-arable land, to a profitable asset equivalent to any yield and oversaw thusly. Numerous Grasslands are currently being recognized as having a multifunctional job in delivering nourishment and restoring harvest lands, in natural the board and social legacy. Be that as it may, Grasslands over the globe are under expanding pressure from expanding human populaces, diminished territories with expanding animals' numbers, and declining terms of exchange for domesticated animals' creation, and they are figured out how to differing degrees of adequacy. The multifaceted nature of Grassland utilizes and the numerous parts of lush biological systems require a structure wherein answers for better administration can be created. An attention on biological system usefulness, for example on water, supplement and vitality cycling and, on the biodiversity, required to continue those capacities, gives a method for settling the difficulties confronted, through the middle person, the board related, criteria of herbage mass, which additionally relates legitimately to creature generation. Accentuation is put on the chances to fulfil different destinations. A thought of the essential connections between stocking rate and Livestock generation shows that the more drawn out term, financially ideal stocking rate is related with improved natural results. There might be ecological goals that go past financially economical cut off points for domesticated animal rearing and in those cases direct instalments from the administration or others will be required. These are probably going to be the place debasement is unmistakably evident. The accomplishment of attractive results in meadow the board that fulfil various goals will require new regions of research that look for suitable answers for ranchers and society.

2.5 Government Policies and its Interventions

Land management in Rural Planning and the Government

Watershed Development Component of Pradhan Mantri Krishi Sinchayee Yojana

“The Department of Land Resources, Ministry of Rural Development has been implementing an area development programme i.e. Integrated Watershed Management Programme (IWMP) w.e.f. 26.02.2009 principally for development of rainfed portions of net cultivated area and culturable wastelands. The activities undertaken inter alia include ridge area treatment, drainage line treatment, soil and moisture conservation, rain water harvesting, nursery raising, afforestation, horticulture, pasture development, livelihoods for resource-less persons, etc. Subsequent to approval of Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), IWMP was subsumed as one of its components. The Operational Guidelines of PMKSY were approved on 26.10.2015 as per which IWMP is implemented as Watershed Development Component of PMKSY (WDC-PMKSY).

Source: Department of Land Resources, GOI

The Main Features of WDC-PMKSY are as below:

- i. According to the Common Guidelines for Watershed Development Projects-2008 (Revised Edition-2011), the period for finishing PMKSY (Watershed Development) ventures is between 4-7 years. The exercises to be taken up are appropriated more than three stages. The Preparatory Phase (1 to 2 years) includes planning of DPR, Entry Point Activities and Institution and Capacity Building. The Watershed Works Phase (2 to 3 years) includes the Watershed Development Works, Livelihood Activities for the benefit less people and Production System and Micro Enterprises. The Consolidation and Withdrawal Phase (1 to 2 years) includes union and culmination of different works.
- ii. The cost standard for IWMP is Rs. 15,000/- per ha for uneven and troublesome zone, Rs. 12,000/- per ha for different zones and up to Rs. 15,000 for each ha for IWMP extends in Integrated Action Plan (IAP) Districts. While the financing design among Centre and States in the past IWMP was 90:10, the subsidizing design under Watershed Development Component of PMKSY is 60:40. However, for North-Eastern States and Hill States (J&K, H.P and Uttarakhand) the subsidizing design among Centre and the States keeps on being 90:10. The activities under IWMP attempt a group of miniaturized scale watersheds of region around 5000 ha in rain fed/debased territories having no guaranteed water system. Devoted organizations are additionally given at Centre, State and District levels. The program lays accentuation on careful arranging and limit working, by giving an exceptional arrangement of 1 % for readiness of Detailed Project Report (DPR) and 5 % for Institution and Capacity Building.
- iii. Institutional set up for usage of IWMP
 - a) **Ministry Level:** The Department of Land Resources has the vital institutional system through Steering Committee led by the Secretary, DoLR for successful and proficient administration of watershed ventures. This Committee bury alia assesses and clears the task proposition of the States. The Steering Committee comprises of individuals from Department of Land Resources, the National Institution for Transforming India (NITI) Aayog, Ministry of Science and Technology, Department of Drinking Water Supply, Department of Agriculture, Cooperation and Farmers Welfare, Department of Rural Development, Ministry of Water Resources, River Development and Ganga Rejuvenation, Ministry of Environment, Forest and Climate Change, National Rural Livelihoods Mission, (Ministry of Rural Development), Department of Animal Husbandry, Dairying and Fisheries, Department of Agricultural Research and Education, Ministry of Skill Development and Entrepreneurship, Central Ground Water Board, Indira Gandhi National open University (IGNOU), National Bank for Agriculture and Rural Development (NABARD), associations in Space Technology (NRSA, ISRO, FSI), three associations in the field of watershed the board (ICRISAT, CRIDA, MANAGE and so on.), National Informatics Centre (NIC) , agent from NRAA as a Special

Invitee for approach matters, three to five specialists in the field of watershed the executives and three rumoured NGOs.

- b) **State Level:** A State Level Nodal Agency (SLNA) has been comprised with expert help. The SLNA is the committed organization for the execution of IWMP in the State.
- c) **District Level:** Watershed Cell-cum-Data Centre (WCDC) is the District level foundation to regulate and arrange IWMP extends in the District. WCDC is set up in DRDA/Zilla Parishad/District Level Implementing Agency/Department in all program locales according to the comfort of the State Governments.
- d) **Project Level:** Project execution is administered by the Project Implementing Agency (PIA). According to the Common Guidelines for Watershed Projects, 2008 (Revised 2011), Panchayats, Government and Non-Government organizations may work as PIAs. Every PIA is to have a Watershed Development Team (WDT) including 3 to 4 specialized specialists.
- e) **Village Level:** Watershed Committee (WC) is established by the Gram Sabha for execution of the undertaking at field level. It contains in any event 10 individuals, half of which are agents of SHGs and User Groups (UGs), SC/STs, ladies and landless. One part from WDT is additionally spoken to in WC.

New Initiatives by the Government

DoLR has taken various new activities to patch up execution of watershed program as point by point underneath:

(I) Srishti and Drishti 'Bhuvan Portal' created by ISRO/NRSC has been propelled on 19.02.2015 by Hon'ble Minister of Rural Development for arranging and checking of undertakings.

- a) Srishti is a GIS based Geo-entry created to help with checking, assessment, change appraisal and give contributions to intending to watershed the board and arrangement of Detailed Project Reports (DPR).
- b) Drishti is the Mobile Application device to catch information including visuals from the field for constant observing of IWMP ventures. The apparatus can likewise be utilized for network checking of IWMP works.

(ii) The Department is actualizing the Public Finance Management System (PFMS) created by the Office of Controller General of Accounts in IWMP. The framework is being utilized to cause instalments, to execute consumption recording and track use of resources in close to continuous during usage of IWMP.

(iii) A combination grid in interview with different Ministries and States has been created. The grid records the different Ministries/Departments, offices/establishments and sets down obligations inside the IWMP actualizing organizations to make progress toward combination at the field level. The Convergence Matrix would be an obligatory piece of DPR.

(iv) Department of Land Resources has taken another activity for Concurrent Monitoring and Evaluation of the IWMP ventures. In such manner a significant number of the States have just chosen the free Evaluation Agencies. The Department has likewise named three organizations for outsider Monitoring and Evaluation of the Watershed Development Component of PMKSY for the North, West and North East areas. The procedure of choice of offices for the South and East districts is under procedure.

Convergence

The central accentuation is on subjective and opportune execution of the watershed advancement ventures, with one: ideal use of accessible budgetary help, two: combination with applicable Central and State plans and three: prioritization of undertakings/venture exercises. To advance the resources activity has been started for marking a MoU with the three Departments in Ministry of Agriculture and Farmers Welfare, in particular (I) Department of Agriculture, Cooperation and Farmers Welfare, (ii) Department of Animal Husbandry, Dairying and Fisheries and (iii) Department of Agricultural Research and Education. Move has additionally been made to attempt Natural

Resources Management exercises by using the work part of MGNREGS and to embrace a portion of the Entry Point Activities in union with Swachh Bharat Mission (Gramin).

Land Use Planning

There will undoubtedly be struggle over land use. The requests for arable land, brushing, ranger service, natural life, the travel industry and urban advancement are more noteworthy than the land assets accessible. In the creating nations, these requests become all the more squeezing each year. The populace subject to the land for nourishment, fuel what's more, business will twofold inside the following 25 to 50 years. Indeed, even where land is as yet copious, numerous individuals may have insufficient access to arrive or to the advantages from its utilization. Despite shortage, the debasement of farmland, woodland or water assets might be clear for all to see however individual land clients come up short on the motivating force or assets to stop it. Land-use arranging is the orderly appraisal of land and water potential, options for land use and monetary and social conditions so as to choose and receive the best land-use alternatives. Its motivation is to select and set in motion those land utilizes that will best address the issues of the individuals while shielding assets for what's to come. The main impetus in arranging is the requirement for change, the requirement for improved the board or the requirement for a very unique example of land utilize managed by evolving conditions. A wide range of rustic land uses are included: agribusiness, pastoralism, ranger service, untamed life protection and the travel industry. Arranging likewise gives direction in instances of contention between country land use and urban or modern extension, by demonstrating which regions of land are most important under country use.

When Land Planning is useful is what must be known to all the stakeholders of the rural and land resource management team? Two conditions must be met if arranging is to be helpful:

- The requirement for changes in land use, or activity to anticipate some undesirable change must be acknowledged by the individuals in question;
- There must be the political will and capacity to place the arrangement into impact.

Where these conditions are not met, but issues are squeezing, it might be proper to mount a mindfulness crusade or set up show territories with the point of making the conditions fundamental for powerful arranging.

The planning process Land-use planning can be expressed in the following questions:

- What is the present situation?
- Is change desirable? If so:
- What needs to be changed? Land-use problems and opportunities are identified by discussions with the people involved and by the study of their needs and the resources of the area.
- How can the changes be made? Planners seek a range of ways to make use of the opportunities and solve the problems.
- Which is the best option?
- Decision-makers choose the best option, based on forecasts of the results of implementing each alternative.
- How far is the plan succeeding? Once a land-use plan is put into effect, planners monitor progress made towards its goals and change the plan if necessary.

Land Use Planning at various Levels –

1. National Level: At the national level, arranging is worried about national objectives and the designation of assets. In numerous cases, national land-use arranging doesn't include the real distribution of land for various uses, yet the foundation of needs for area level undertakings. A national land-use plan may cover:

- Land-use strategy: adjusting the contending requests for land among various parts of the economy nourishment generation, send out harvests, the travel industry, untamed life preservation, lodging and open enhancements, streets, industry;

- National improvement plans and spending plan: venture ID and the assignment of assets for improvement;
- Coordination of sectoral organizations associated with land use;
- Enactment on such subjects as land residency, timberland leeway and water rights.

National objectives are mind boggling while arrangement choices, enactment and financial estimates influence numerous individuals furthermore, wide territories. Leaders can't in any way, shape or form is authorities in all aspects of land use, so the organizers' obligation is to exhibit the important data in wording that the chiefs can both grasp and follow up on.

2. District Level: District level alludes not really to authoritative regions yet additionally to arrive at zones that fall between national and nearby levels. Improvement ventures are regularly at this level, where arranging first comes to grasps with the decent variety of the land and its appropriateness to meet task objectives. When arranging is started broadly, national needs must be converted into neighbourhood plans. Clashes among national and nearby interests should be settled. The sorts of issues handled at this stage include:

- The setting of advancements, for example, new settlements, woodland ranches and water system plans;
- The requirement for improved framework, for example, water supply, streets and showcasing offices;
- The advancement of the board rules for improved sorts of land use on each kind of land.

3. Local Level: The neighbourhood arranging unit might be the town, a gathering of towns or a little water catchment. At this level, it is most straightforward to fit the arrangement to the individuals, utilizing neighbourhood individuals' information and commitments. Where arranging is started at the area level, the program of work to actualize changes in land use or the board must be completed locally. Then again, this might be the primary level of arranging, with its needs drawn up by the nearby individuals. Nearby level arranging is tied in with completing things on specific zones of land - what will be done where and when, and who will be dependable.

Pilot Project on Land Use Planning and Management

Land is a rare resource required by various areas of the economy like Agriculture, industry, mining, for foundation improvement, urban arranging, open utilities, lodging, and so on and there are contending totally unrelated and regularly clashing requests for land and its resources by these financial parts and for social needs. In this unique situation, it is basic that compelling area use arranging and the executive's frameworks are set up. Under an Agreement for "Specialized Co-activity" between Government of India and Government of Federal Republic of Germany marked on 31st December 1971; an Implementation Agreement was marked on seventh October 2015 between the Department of Land Resources, Government of India and Deutsch Gesellschafts hide Internationale Zusammenarbeit (GIZ), Germany for a pilot in two States "Ashore Use Planning and Management Project".

The venture expects to empower arranging organizations/farms of accomplice States to apply instruments of incorporated spatial land use arranging. As a major aspect of the execution understanding, GIZ will give specialized help to the accompanying yields/expectations to be shown in the pilot States of Odisha and Tamil Nadu.

- (i) Development of Land Use Policies (directing ideas and standards);
- (ii) Development of Planning Instruments/apparatuses for Integrated Spatial Land Use Planning;
- (iii) Human Capacity Development (HCD);
- (iv) Organizational and Institutional Development.

The task will likewise create standard working techniques and rules for joint effort and interface with various offices inside the State for spatial planning to advance between sectoral coordination systems among different offices at state level. The Department of Land Resources is planning and encouraging the undertaking. An Inter-Ministerial Steering Committee at national level has been comprised on 28th November, 2016 to guide, screen, assess and encourage usage of the task.

Project Objectives

The goal of the task is to improve the arrangement of land use planning in India so as to empower and guarantee that Indian state planning organizations apply approaches and instruments of incorporated spatial and land use planning. These advanced planning apparatuses and instruments structured under the task can make land use planning increasingly straightforward, and land the board progressively adjusted in connection to the environmental, monetary, and social perspectives. Proposed strategies and standards will control the chosen establishments in creating planning components and instruments, for example, improvement plans for state, regions and metropolitan regions. This additionally incorporates sectoral plans, for example, eco-sensitive zones, extraordinary modern zones, uncommon monetary zones or street prerequisite plans. The venture will create standard working strategies and rules for joint effort and interface with various divisions inside the state for spatial planning. This will likewise advance between sectoral coordination system among different offices at state level, which is a basic essential for incorporated land use planning and the board.

Approach of the Project

In a joint effort with the Department of Land Resources (DoLR), Ministry of Rural Development (MoRD), the venture has distinguished Tamil Nadu and Odisha as two pilot states. Along these lines, the venture works at various sizes of the inside, the states, the regions and the metropolitan levels. GIZ works intimately with the accomplice establishments in the states to create standards and rules of land use strategies, specialized and methodological planning instruments just as limit building programs for land use planning. Moreover, the venture means to make a culture of spatial planning by showing the possibility of a regularizing approach of land use planning and the board.

Digital India Land Record Modernization Programme

The Land Reforms (LR) Division was executing two Centrally Sponsored Schemes viz.: Computerisation of Land Records (CLR) and Strengthening of Revenue Administration and Updating of Land Records (SRA&ULR). Later on, 21.8.2008, the Cabinet affirmed merger of these plans into an adjusted Scheme named Digital India Land Records Modernization Program (DILRMP). The fundamental points of DILRMP are to introduce an arrangement of refreshed land records, robotized and programmed transformation, reconciliation among literary and spatial records, between availability among income and enrolment, to supplant the present deeds enlistment and possible title framework with that of convincing titling with title ensure.

The DILRMP has 3 significant parts –

- (a) Computerization of land record
- (b) Survey/re-overview
- (c) Computerization of Registration.

The District has been taken as the unit of execution, where all program exercises are to combine. It is trusted that all regions in the nation would be secured before the finish of the twelfth Plan time frame aside from where cadastral studies are being accomplished.

National Mission for Sustainable Agriculture (NMSA)

NMSA is visualized as one of the eight Missions plot under National Action Plan on Climate Change (NAPCC), NMSA target advancing Sustainable Agriculture through environmental change adjustment

measures. The significant push is improving agribusiness profitability particularly in rainfed territories concentrating on incorporated cultivating, soil wellbeing the board, and synergizing resource preservation. In addition to it NMSA has a submitted objective to satisfy National and International duties on Sustainable Development Goals (SDG) & Intended Nationally Determined Contribution (INDC). Each of the segments of NMSA, for example, Rainfed Agriculture, Soil Health Management, Organic Farming etc have huge job in accomplishing SDGs.

NMSA as an automatic mediation takes into account Mission Deliverables that spotlights chiefly on preservation agribusiness to make farm segment progressively gainful, feasible, profitable and atmosphere versatile by advancing area explicit coordinated/composite cultivating frameworks; soil and dampness protection measures; extensive soil wellbeing the executives and mainstreaming rainfed advancements.

NMSA has the following schemes

- a) Rainfed Area Development (RAD): RAD is being implemented by RFS Division.
- b) Sub Mission on Agro Forestry (SMAF): SMAF is being implemented by NRM Division
- c) Paramparagat Krishi Vikas Yojana (PKVY): PKVY is being implemented by INM Division
- d) Soil and Land Use Survey of India (SLUSI): Being implemented by INM Division
- e) National Rainfed Area Authority (NRAA): Being implemented by RFS Division
- f) Mission Organic Value Chain Development in North Eastern Region (MOVCDNER): Being implemented by INM Division
- g) National Centre of Organic Farming (NCOF): Being implemented by INM Division
- h) Central Fertilizer Quality Control and Training Institute (CFQC&TI): Being implemented by INM Division.

Rainfed Area Development (RAD) - RAD centres around Integrated Farming System (IFS) for upgrading efficiency and limiting dangers related with climatic variability. Under this framework, crops/trimming framework is coordinated with exercises like agriculture, domesticated animals, fishery, agro-ranger service, apiculture and so forth to empower farmers not just in augmenting homestead returns for supporting business, yet in addition to relieve the effects of dry season, flood or other outrageous climate occasions with the salary opportunity from associated exercises during yield harm.

On Farm Water Management (OFWM):- OFWM will concentrate basically on upgrading water use effectiveness by advancing proficient on-farm water the executives advance also. This won't just concentrate on application productivity be that as it may, related with RAD part, additionally will underscore on viable reaping and the executives of water. Help will be stretched out for embracing water protection innovations, effective conveyance and dissemination frameworks and so on. Accentuation will likewise be given to oversee and fairly appropriate the resources of centre by including the water client's affiliations, and so on... To save water on homestead itself, farm lakes might be burrowed utilizing MGNREGA resources and earth moving hardware (to the degree manual burrowing under MGNREGA isn't attainable).

Soil Health Management (SHM)- SHM will target advancing area also as harvest explicit economical soil wellbeing the executives including building-up the board, natural cultivating rehearses by method for making and connecting soil fruitfulness maps with full scale smaller scale supplement the board, proper land use in view of land capacity, sensible use of manures and limiting the soil degradation/degradation. Help will be accommodated different improved bundle of practices dependent ashore use and soil qualities, created through topographical data framework (GIS) put together topical maps and database with respect to land and soil attributes through broad field level logical reviews. Moreover, this segment will likewise offer help to recovery of issue soils (corrosive/basic/saline). This segment will be actualized by State Govt., National Centre of Organic

Farming (NCOF), Central Fertilizer Quality Control and Training Institute (CFQC&TI) and Soil and Land Use Survey of India (SLUSI). Given the constraints, for example, staff and framework, looked by the office of agribusiness at the field level, a Public Private Partnership Model might be embraced by states relying on the private accomplice's quality in the field to guarantee that the dirt testing is done in time and in the numbers required. The private gatherings can be urged to set up soil testing labs in those zones in the locale.

Climate Change and Sustainable Agriculture: Monitoring, Modelling and Networking (CCSAMMN) - CCSAMMN will give creation and bidirectional (land/farmers to look into/logical foundations and the other way around) scattering of environmental change related data and information by method for directing atmosphere change adjustment/moderation look into/model undertakings in the space of atmosphere brilliant reasonable administration practices and incorporated cultivating framework appropriate to neighbourhood agro-climatic conditions. The devoted master groups of specialized staff will be systematized inside NMSA to thoroughly screen and assess the strategic thrice in a year and will educate the National Committee. Far reaching pilot squares will be upheld to outline utilitarian instrument for scattering of rainfed advances, arranging, union and coordination with lead plans/Missions like MGNREGS, IWMP, Accelerated Irrigation, Advantage Program (AIBP), RKVY, NFSM, MIDH, NMAET and so forth. Such an incorporated activity of info and yield streams crosswise over farming, domesticated animals and other creation frameworks will bridle the development capability of the rainfed generation frameworks, conferring manageability of nearby creation frameworks while arranging atmosphere change dangers. A consortium approach will be developed with different partners counting information accomplices like State Agricultural Universities (SAUs), Krishi Vigyan Kendras (KVKs), Indian Council of Agricultural Research (ICAR) Institutes and so forth by the State Government to give single window administration/information supplier framework to serve cultivating network. Money related help might be given through States to systematize the idea and meeting beneficial formative exercises. Environmental change related observing, criticism, learning systems administration and expertise improvement will likewise be bolstered under this part through State Agricultural Universities, ICAR Institutes National/International Foundations, KVKs, Public/Private R&D Organizations and so forth. Granting of Studies, Documentation and Publication, Domestic and Foreign Training, Workshops/ Meetings and so forth will be upheld under this segment.

To Do Activity

Group work - Prepare a list of government schemes pertaining to land usage and management undertaken in your state and qualitatively compare the same with National Level Schemes (in terms of inception, target population, procedure to register, procedure to withdraw if any, reach and scope of the schemes.) Organise the class into groups and assign each group a particular state. Make a presentation of not more than 10 slides.

Chapter Summary

The chapter is spread across five units. The first unit talks about the classification of land and its use patterns across India. Within the same the unit talks about the various land forms and usage. Arrangement of land is "a procedure which relegates each body or tract of land in a region to its appropriate class in an arrangement of classes. The classes in the frameworks are characterized regarding the characteristics or attributes with which the characterization is worried." Cultivation in India is generally bound to Tamil Nadu, Gujarat, Maharashtra, West Bengal, U. P., Punjab, Bihar, Orissa, M. P., Haryana and Kerala. About 14.3 percent of the complete trimmed territory of the nation is in U. P. The second most noteworthy level of farming region is in Maharashtra (12.3

percent) trailed by M. P. (11.9 percent) Rajasthan (9.6 percent). Andhra Pradesh (8.3 percent), Bihar (7.2 percent), Karnataka (6.9 percent), Punjab, (6.5 percent), Haryana (6.5 percent), Gujarat (5.3 percent), Tamil Nadu (4.7 percent), West Bengal (4.2 percent) and Assam (1.8 percent). The level of planted territory to add up to land zone fluctuates between various pieces of the nation and is fundamentally controlled by physical state of geography, soil and atmosphere. The facts may demonstrate that entire of this land that is non cultivable may not be fit for development or afforestation, however on the off chance that trees of various kinds, appropriate for various soils, are chosen, a huge extent of these grounds can be put under fuel and grain trees, and fields. During the arranging time frame a portion of the desolate land has been brought under development. The second unit in essence talks about the Degradation of Land and preventive measures. Land degradation is defined as the long-haul loss of environment capacity and efficiency brought about by unsettling influences from which the land can't recoup independent. Land degradation happens gradually and aggregately and has enduring effects on rustic individuals who become expanding powerless. Land degradation is a composite term; it has no single promptly recognizable element, yet portrays how at least one of the land resources (soil, water, vegetation, rocks, air, atmosphere, alleviation) has changed for the more terrible. An avalanche is regularly seen for instance of land degradation in real life – it changes the highlights of the land, causes obliteration of houses, and disturbs exercises. In the more extended term, be that as it may, the zone of an avalanche may recapture its profitability. To mitigate the same practices like sustainable agriculture and afforestation, terrace cultivation and mixed cropping are adopted. The third unit talks about the environmental impacts related to Land resources management. The land use pattern has changed a lot. Conversion of backwoods into croplands and for building structures is most common. Removing trees is the most hazardous impact. Agriculture causes nitrogen, phosphorus, ammonia, pesticides and such to settle in soil and seas. The contamination causes innumerable outcomes. Mining rocks and expelling slope regions cause biodiversity misfortune just as other impacts. Deforestation farming and advancement of urban communities related framework are important highlights. The fourth unit aims at exploring strategies to adopt in tackling issues related to Land resource Management through sustainable farming practices. The last units explain the important government programmes pertaining to land use.

Questions for Discussion

1. Discuss the role of government in safeguarding land resource utilization.
2. What is the impact of Climate Change on Land Resources?
3. What are the key features of PMKSY?
4. How soil health management can help to optimise usage of Land resources?
5. How the Pilot Project was implemented with respect to land management?
6. Which terrains are vulnerable with respect to land degradation?
7. What is the fate of Land not used for Agriculture in terms of Land Resource Management?
8. What are classifications of Land in India?
9. What are the various levels of analyses in Degradation?
10. What factors Contribute to Sensitivity and Resilience?
11. Explain the Land Degradation cycle in the environment?
12. How is Land user's perception different from that of environmentalists in terms of Land Degradation (Hint: Talk about capabilities and resources scarcity on their part).
13. How is reduction in biomass related to land degradation phenomena?

14. How do natural calamities like flood affect the land degradation?
15. What do you understand by climate resilient Agriculture?

To Do Activity

1. Group work - Other than slash and burn agriculture which leads to land and air quality degradation, explore other land degradation phenomena and its implication on the weather and climate change. Write a comprehensive report on the same. Organise class into groups and do this exercise as a group work whereby each group would explore land degradation and management thereof phenomena in their locality.
2. Individual work - Compare the land use pattern of your state of residence and the neighbouring states and comment on the type of soil and difference in utilisation of fallow lands in the states. Prepare a report on the same. Use the concepts from the chapter.

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Chapter 3 Forest Resource Management

Introduction

Forests are crucial in many aspects of the economy of the country and also for its citizens. They are the largest sink for greenhouse gases and consider as the flag bearer in the war against Global Warming. Forests are vast in area and it is difficult to manage forests or stop its depletion. This has resulted in shrinking in a forest coverage area. It has become extremely important to manage forest resources efficiently so that long term benefits can be realized.

Objectives

- To give insights about forest management in general and how it is done in India.
- To discuss forest management and governance in detail and the steps taken by the Indian Government for sustainable forest management.
- To provide insights on the ways to combat the effects of climate change on forest and the various practices so that people will get the maximum benefit out of the forest products.
- To understand how the government laws and policies related to forests and its conservation.

Chapter Structure



3.1 Introduction to Forest Resources Conservation and Management

A forest is a complex ecosystem that is predominantly composed of trees and shrubs. Forests are also storehouses of the large variety of life forms such as plants, mammals, birds, and insects. The forest ecosystem has two components- Abiotic (Non-living) and Biotic (Living) component. Plants and animals constitute biotic components whereas climate and soil type are abiotic components. Social interaction with the forest has been part of human existence right from the beginning as hunter-gatherers, agricultural societies and even the industrial society has been having contact with the forest in some form or the other.

The general understanding from the beginning of forest has been that of an area that is wooded and is a habitat of wild animals including many species of birds and reptiles and isn't subjected to the laws of civility. This understanding outspreads further also to include the notion that many articles of use to man are grown in the forest naturally and have to be attained from there. It is concerning these articles and their extraction that some adjustments get induced which is culture-specific. This unit attempts to make you aware of the changing notion of the forest as a resource. Forests have been examined here concerning various raw materials they supplied. The unit talks about the governance of forest resources in India, the innovative approaches followed by the government (Joint Forest Management) and the institutional support provided for forests of India.

Role of Forest in the ecosystem

- Forests help in regulating global temperature.
- Forests act as an excellent absorber and absorb CO₂ and other greenhouse gases.
- Forests renew the oxygen supply in the atmosphere by absorbing atmospheric CO₂ and releasing oxygen through the process of photosynthesis.
- Forests play a vital role in maintaining the hydrological cycle.
- Forests prevent soil erosion.
- The organic matter from the forest is carried by rivers which in turn supports the aquatic animals. Thus, forests play a crucial role in maintaining healthy watershed.
- It provides forest food to communities, grazing land to livestock.
- Forests also provide plants that have great medicinal value and use to cure critical illnesses.

Contribution to the Economy

- It provides products such as timber, paper, fuel wood, essential oils and some valuable non-timber forest produce such as Mahua, Tendu leaves.
- Forests provide fodder for cattle and it is a useful source of fodder during drought.
- Forest plants provide different kinds of medicinal plants, spices, poisons, Tendu leaves, etc.

Forest Coverage in India

Forests are natural vegetation cover in India. The difference in geographical and topographical conditions have given rise to different species of plant from thorny bushes to tall Pine and Deodar. The current forest spread in India is highly uneven ranging from deserts in some regions (Delhi 1.5%, Rajasthan 2.5%) to nearly thick forests in other regions (Himachal Pradesh 33%, Madhya Pradesh 31%). Tripura (63%) and the Andaman-Nicobar Islands have exceptionally high forest cover. It is difficult to find original forest cover in India considering the highly varying geography. The forest cover in plains is removed for human occupancy.

The plant species, climate, land separately or in combinations, define the forest types. Indian forests species do well in their respective environment such as Deodar trees are mainly found in Himalayan belt whereas spices and medicinal plants are usually found in southern India. Some species grow all over the country (such as Neem, Pipal, Banyan, Tamarind, Palm, etc.). The pastures with shrubs and grasses are found in usually in sub-humid areas of the country. Per State of Forests Report (SFR) of 2003, which is based on remote sensing, indicates the tree canopy cover of over 67.83 mha i.e. 20.64% of the land area. Out of this total, 5.128 mha (1.56%) is very dense, 33.39 m ha (10.32%) in moderately dense and 28.78 m ha (8.67%) comes in open canopy category.

In addition to this, The Steering Committee on the Environment and Forests Section 13, nearly 10 mha areas has been assessed. The assessment is done for the leftover area where remote sensing was not possible. As per the report, under tree cover outside the Government-controlled forest lands is up to 77.83 mha or 23.68% of the land area of the country. The report has critically analyzed the rapidly reducing good forests even though the forest cover remains the same.

“Forest cover in India is defined as the land more than one hectare in an area having a tree canopy density of 10% or more.”

Table 3.1 Types of forests based on area density

Very Dense Forest	All lands with a tree cover of canopy density of 70% and above
Moderately Dense Forest	All lands with a tree cover of canopy density between 40% and 70%
Open Forest	All lands with a tree cover of canopy density between 10% and 40%
Scrub	Degraded forest lands with canopy density less than 10%
Non-forest	Any area not included in the above classes

The forest cover differs in different states of India. Madhya Pradesh stands at the top with the largest forest cover. It is followed by Arunachal Pradesh, Chhattisgarh, Maharashtra, and Odisha. North-eastern states have one-fourth of the total forest cover of India. Haryana has the least forest cover among all the states in India. Punjab and Goa come on the second and third positions from the bottom.

Table 3.2 States wise forest coverage (sq km)

State	Total Forest Cover (Sq.Km)
Madhya Pradesh	77, 522
Arunachal Pradesh	67, 321
Chhattisgarh	55,621
Maharashtra	50,632
Odisha	50,347
Haryana	1586 (least)
Punjab	1772
Goa	2229
Sikkim	3358
Bihar	7291
Tripura	7866

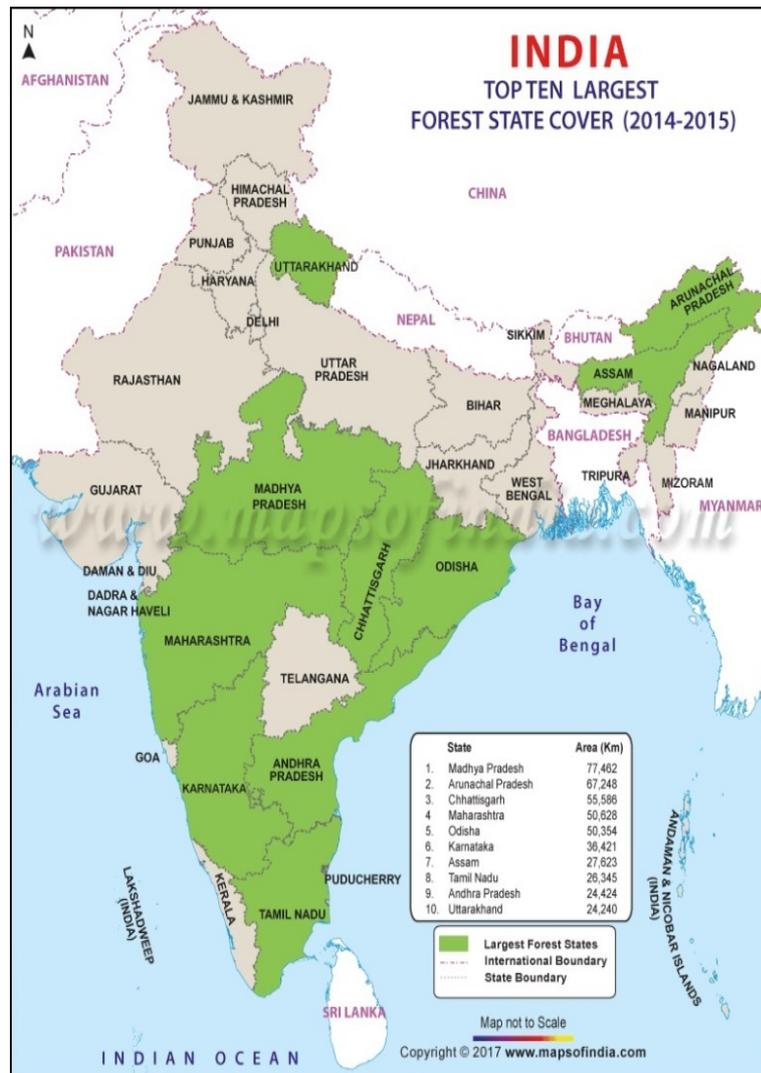


Figure 3-1 Top 10 states in forest coverage area in India (Source : maps of India)

Major Forest Resources in India

Teak Forest – Teak forests have covered the largest area in Madhya Pradesh. Its wood is used for building boats, furniture, and other small wooden items.

Sal Forests - The expansion of **Sal forests** is from Kangra in Himachal Pradesh to the Terai areas of Navgaon district in Assam. These forests are also found in Uttar Pradesh, Madhya Pradesh, Northern Tamil Nadu, Bihar, Jharkhand, and Odisha. Sal is hardwood timber and it is tough and coarse. It is used as premium quality wood.

The Shisham forests- These forests are found in Uttar Pradesh, Tamil Nadu, Bihar, Madhya Pradesh, and West Bengal. Shisham wood has demand in the international market as well. It is also used for fuelwood and building sheds.

The Sandalwood trees- The forest area covered by sandalwood is not large but it has more economic value than any other forest. These are found mostly in Karnataka followed by Tamil Nadu. Its wood has fragrance and medicinal properties.

The Deodar trees- Deodar trees are mostly found in the Himalayan region. Deodar is used in the treatment of different illnesses. Its woods are used for making train seats by Indian railways.

Pine Forests- Pine trees are found at greater heights, mostly in the Himalayan belt.

The Tendu trees- Tendu trees are found mostly in Madhya Pradesh. Its leaves are used for making beedis.

Major and Minor Forest Produce

Major Forest Produce

The most important forest produce in terms of economic value and volume are timber, pulpwood, fuel, and fodder.

1. Timber and pulpwood

While timber and pulpwood have a large commercial and environmental reputation, fuel, fodder, and NTFP constitute the basic needs of rural areas. In 2006, a demand-supply gap of almost 64 million cubic meters was projected by the Timber National Forestry Action Programme of the MOEF. The shortage, especially in the industrial sector, is being met through import since 1985 for raw material or finished products like logs, pulp, paper, newsprint, plywood, etc. amounting to nearly Rs. 9000 crores (2003-2004). Timber is the most environment-friendly structural material that needs to be encouraged also compared to the present material like plastic, composites, and metals. The augmented productivity of the forests itself can play a substantial role in fulfilling this requirement.

2. Fuel wood

Fuel wood is an important basic need for 40 percent of the population of India. The annual fuel wood requirement for the country is estimated at around 200 million tonnes which is much more than the fuel wood available on a sustainable basis. The fuel wood consumption varies from warm to colder in increasing order.

Fuel wood is the most preferred fuel in rural areas because it is being collected from common property i.e. forests. On a sustainable basis, around 17 million tonnes of wood (Steering Committee Report, 2013-18) are available as fuel wood. Since there is no curb from the government, more wood is taken by forest dwellers from the forest without keeping in mind that India may have sufficient food to eat but not sufficient fuel wood to cook it.

3. Fodder

The one-third requirement of fodder is fulfilled by forests in India. During drought, the dependence on forests increases more. Even though the grasslands are the most productive ecosystems, there is no strong mechanism to manage fodder. Therefore, fodder is not available throughout the year and villagers turn to forests for grazing their livestock. Projections of FSI indicate that 33% of fodder supplies come from forest areas through lopping and grazing.

Minor Forest Produce

Minor forest produce is mostly non-wood products. It involved products such as Mahua, tamarind, Tendu Patta, Tusser, Cocoon, Cane, and Bamboo.

As per Section 3(1)(c) of Forest Rights Act, forest-dependent communities not only have rights of use over Minor Forest Produce(MFP) but they also have ownership over MFPs. About 100 million people derive part of their livelihood from selling non-timber forest produce (National Committee Report,2010). The government of India has launched a central scheme and decided Minimum Support Price (MSP) to ensure fair monetary returns over MFP. NTFP includes items like Tendu leaves, Mahua, Sal, etc. These items have huge demand commercially. The harvesting and management of NTFPs are done through various mechanisms which include contracts, participatory systems and working as cooperatives.

Bamboo as a Minor Forest Produce

In the Forest Rights Act, 2006, Bamboo has given the status of forest produce. This act gives forest-dependent communities the right to collect bamboo from the forests. Its selling rights are also reserved for these communities living in and around forest areas where Bamboo grows.

Ecological and Economical Importance of Forests

Ecological Importance

1. Production of Oxygen

Oxygen is necessary for human survival and forests are known as the lungs of the earth because they release oxygen during photosynthesis.

2. Regulation of global climate and temperature

Forest plays a vital role in regulating the global climate and temperature. Forest cover absorbs the solar radiation that would otherwise be stayed in the lower atmosphere and increase global temperature. Forests also regulate the hydrological cycle through the transpiration of plants that increase the atmospheric humidity. This humidity affects the rainfall and cools the atmosphere.

3. Reduction of Global Warming

Forests absorb the greenhouse gas Carbon-dioxide (CO₂) in large amounts for photosynthesis. Therefore, forests act as a sink for CO₂ and help in reducing global warming.

4. Conservation of Soil

Forests prevent soil erosion by binding the soil particles tightly in their roots. This prevents erosion of soil by wind and rain.

Forests also improve the fertility of the soil, control the water flow, provide habitat to wildlife and absorb noise and air pollutants.

Economic Importance

Forests are of great economic importance for forest-dependent communities. The cash-generating forest products are as follows.

1. Timber – Wood is used for commercial purposes by mankind. Timber is essential in making furniture, boats, bridges, and roofs of houses.
2. Fuel Wood – The use of LPG still limited in the country. Most of the poor households still use wood for cooking purposes.
3. The raw material for wood-based industries – Raw materials such as paper, pulp, etc. obtained from forests are important in various industries. Forest mainly provides raw materials for sports goods, matchboxes, etc.
4. Food – Forests provide fruits, roots, leave of plants and trees along with the meat of forest animals to tribal people.
5. Medicines- Various medicinal plants are obtained from forests.

Forest provides other products like Resin, rubber, gum, oils, Katha, honey, etc.

Types of Forests in India

1. Tropical dry deciduous forest
2. Tropical moist deciduous forest
3. Tropical Wet Evergreen forest
4. Tropical semi-evergreen forest

Forests as carbon sinks

The vegetation and soils of the world's forests contain a vast quantity of carbon- more than one-and-a-quarter times the amount stored in atmosphere. CO₂ is released when forests are cleared or degraded and vegetation is burned or decays. Burning forest vegetation also releases other greenhouse gases including methane (CH₄), nitrous oxide (N₂O), carbon monoxide(NO₄).

When forests grow, CO₂ is withdrawn from atmosphere through photosynthesis and stored as carbon in the vegetation. Levels of carbon in the soil may be increased by reforestation and other management practices. Currently, the world's forests are estimated to be net resources of CO₂, primarily due to deforestation and forest degradation in the tropics. Temperate and boreal forests, which overall are slightly increasing in area and in some places in biomass per unit area, are net carbon sinks. The following three forests related strategies have been proposed as means to influence CO₂ emissions.

1. Maintaining existing carbon stocks through forest management and conservation;
2. Increasing storage of carbon in forests (by increasing forest area or biomass per unit area) and in forest products; and
3. Substituting fossil fuels with fuelwood from sustainably managed forests and substituting energy-expensive products (for example: steel, aluminium, concrete) with industrial wood products.

Source: World Bank Report on Natural Resource

5. Littoral and Swamp forest
6. Tropical rainforest
7. Subtropical forest
8. Temperate broad-leaved forest
9. Temperate conifer forest
10. Subalpine forest
11. Alpine forest
12. Desert thorny forest
13. Coastal dune forest
14. Estuarine evergreen forest
15. Grasslands
16. Montane Wet Temperate Forest (Joshi, 2009)

Among the 16 different forest types of the country, the most common is
 Tropical dry deciduous (38.7%)
 Tropical moist deciduous (30.9%)
 Tropical thorn (6.9%)

These 3 types of tropical deciduous forests account for 76.5% of forest area in India. Nearly, 96% of the forest area is owned by the government and 2.6% by corporate bodies and the rest of the area is under private ownership.

Deforestation

Deforestation is defined as the permanent destruction of forests. Removal of plantations of tea, coffee or gum is not included under deforestation. Deforestation has resulted in an imbalance in the environment.

Causes of Deforestation

1) Population Explosion

Population explosion is the main reason for deforestation. Humans have developed houses, factories, agricultural land, etc. at the expense of vast areas of forests. As the population grows exponentially; the demand for forest products increases manifold. Timber, firewood and paper are important forest products for mankind and the need for forest products initiated deforestation.

2) Forest Fires

Forest fires can destroy the entire forest in one go. The fire in the forests may be due to natural calamities or human activities. Various kinds of forest fires are given below

- a. **Ground fires:** When smouldering of the humus and organic matter forming a thick cover of fire over the forest floor.
- b. **Surface Fires:** When the dried twigs and leaves catch fire.
- c. **Crown Fires:** When the treetops catch fire due to constant rubbing against each other and excess heat production.
- d. Apart from natural reasons, fires can also be caused by stubble burning, throwing burning cigarettes in forests or human activities for constructing roads and railway tracks.

3) Overgrazing by livestock

The communities, living in and around forests, use the forest for the grazing of animals. This hampers the porosity of the soil, cause soil erosion, and desertification.

4) **Natural Calamities**

Snow, lightning, floods and other natural calamities also damage forests

5) **Pest Attack**

Forest pests are dangerous for forests as they attack the leaves, shoots, and roots of the trees.

Effects of Deforestation

Deforestation has long time effects on the ecosystem. So far, the following consequences have been observed.

- a) Indigenous species of animals become extinct because of their natural habitat destruction.
- b) Soil erosion has increased in the absence of vegetation cover over the soil surface.
- c) With the reducing number of trees, the amount of oxygen liberated by plants through photosynthesis is also reducing.
- d) Loss of cultural and biodiversity
- e) A decrease in the availability of essential forest products like fuelwood, timber, paper, etc.
- f) Increase in pollution due to the burning of wood and due to a reduction in Carbon-dioxide fixation by plants.
- g) An increase in Carbon dioxide levels in the lower environment of the earth which in turn results in global warming. Due to global warming ice caps and glaciers are melting and sea level is increasing the coastal areas.
- h) The groundwater level is reducing as soil is unable to hold water in the absence of trees and rainwater run-off.

Conservation of Forest Resources

Forest Conservation Act of 1980

Forest Conservation Act, 1980, amended 1988, Rules, 1981, amended 1988, 1992, 2003- provides for the protection of and the conservation of the forests.”(MOEF&CC GoI, 2019)

Goals of the Forest Conservation Act

1. To protect the forest, its diverse ecological components
2. To protect the territory, integrity, and individuality of forests

The roles of the central government and state government have been mentioned in the act. Prior approval of the Central government is required for any kind of diversion of forest land or non-forest purpose.

Approval in 2 stages

MoEF (Ministry of Environment and Forests) leads the way for prior approvals of the state/UT government in 2 stages: First in-principle or stage-1 approval and stage-2 approval on compliance. While any state government decides to permit the use of forest land for the non-forest purpose, the conditions and safeguards issued by the central government are followed. Also, stage 1 and 2 clearances are taken. (MOEF&CC GoI, 2019)

Monitoring

The state/UT government is the custodian of forests in their respective State/UT and they are responsible to monitor the compliance of conditions of diversion.

Non-Forest Purpose

As per the latest guidelines, the following activities are classified as non-forest purpose (MOEF&CC GoI, 2019)

1. Cultivations of tea, coffee, spices, and rubber
2. Cultivation of fruit-bearing trees or oil-bearing plants or medicinal plants

3. Ecotourism is non-forest activity and requires prior approval from the government

MOEF&CC maintains close contact with the States in matters related to forest conservation. There is a need for a national database on the forestry-related aspects which should also include state-level developments. A well-managed system of monitoring State level forestry developments should be designed which would record all the production and trade-related data and demand/supply situations. This system can help the ministry to a great extent in planning and policy formulation in the future.

To do Activity

- Group work – Organize the class into group of 5 and assign each group one forest type. Prepare a report on the forest cover of respected forest type, flora and fauna found in respective type of forest. Prepare a short 5-minute presentation of not more than 10 slides.
- Individual work – Identify the impact of deforestation in India and how technology can be used to conserve forest resource. Prepare a report of maximum 500 words.

3.2 Importance of Forest Management and Governance

Meaning of Governance

Governance is different from the government. The government is a mere actor in the process. Governance is about how power is exercised to manage the country's resources.

The notion of good governance is ideal and difficult to achieve. It varies with the states in India. Governance permits and ensures to enhance several opportunities of livelihood for the individuals.

Meaning of Forest Governance

Forests play a vital role in the social and economic progress of the country. At the same time, it also maintains a balance among various ecological components. Forests provide a livelihood to poor people living in and around the forest areas. The governance of forests is necessary to prevent deforestation and give rights to forest-dependent communities. If not carefully managed, there will be conflict among the government and the communities. Government and forest-dependent communities work hand in hand to take maximum benefit of forest resources without harming them. Forests fulfil multiple functions which are valued differently by different groups of people at different levels.

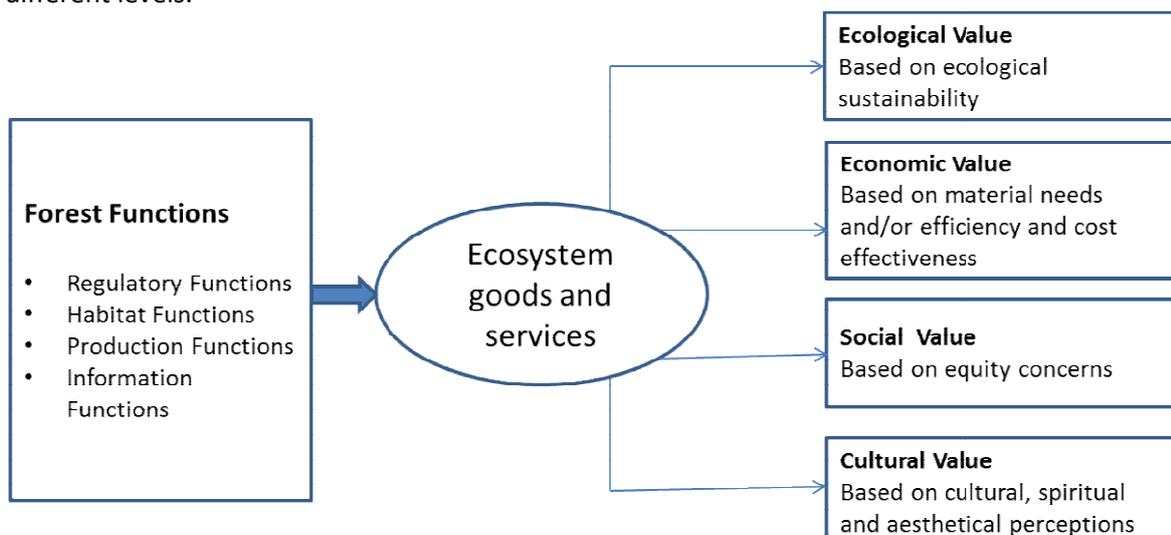


Figure 3. 2 Forest functions and their values

Forest governance is about what ends, forests are managed. How decisions on forest land and its use for non-forest purpose are taken and who all are involved in these decisions. To enforce forest laws and policies on the ground good forest governance should cope with critical issues like pollution, deforestation, illegal logging and corruption, Taking control from forest-dependent communities, carbon sequestration, and watershed protection.

Forest Management and Governance in India

The governance of forest resources in India may be divided into three categories (Singhal, 2016):

- (a) Governance at State level
 1. Ministry of Environment, Forests and Climate change (MOEF&CC)
 2. State Forest departments
- (b) Joint governance by State and communities
 1. Van Panchayat
 2. Joint Forest Management (JFM)
- (c) Governance by civil society
 1. Tree Growers cooperative societies
 2. Farm forestry cooperatives
 3. Community forestry

The objectives of fine forest governance are effectiveness, equity, sustainability, and efficiency. The assessment of the governance is done by looking into the quality of

- (1) The prevailing institutions
- (2) Their delivery mechanisms
- (3) The offered policy framework

Governance by State

MOEF&CC governs the forests at the state level and State Forest Departments are accountable at the state level.

Ministry of Environment, Forests and Climate change (MOEF&CC)

The MOEF&CC is accountable for coming up with designing, planning, promotion, coordination and overseeing the implementation of the forestry policies and programs with the subsequent objectives:

1. Conversion and regeneration of forests
2. Conservation and survey of flora and fauna and other ecological components of the forest
3. Protection of environment
4. Hindrance and management of pollution

State Forest Departments

The State Forest Departments are responsible for planning, implementation, and monitoring of programs in the forestry sector at the state level through circles, divisions, and ranges.

(a) Joint Governance by State and Civil Society

Joint governance by the State and civil society is observed in India mainly in two forms, namely, (1) Van Panchayat, and (2) Joint Forest management. In the case of Van Panchayat, the State is represented by the Revenue Department. In the case of Joint Forest Management, the State is represented by the Forest Department.

1. Van Panchayat

Forest Department is created in 1868 and the Forest Act was implemented in 1868 and 1878 subsequently. The act led to limiting the rights of the forest communities for the use of forest areas. This caused widespread protests in the hilly areas of Uttaranchal (earlier part of Uttar Pradesh) which had very little agricultural land and the people depended heavily on their livelihood on the other areas most of which had been put under the category of the forest land

under successive settlements. In 1921, Kumaon Forest Grievances Committee recommended reverting the forest areas having no tree species of commercial importance (Class-I) to the Revenue Department while access for the other forest areas was allowed for grazing, lopping, and firewood.

The Revenue Department and the concerned village organized Van Panchayat for the joint management of the civil forests (Class-I) for the first time in 1932. The Van Panchayat of the respective village was expected to look after the forest land falling in that village. The Van Panchayat Act of 1971 came to limit the concessions available to the people earlier in Van Panchayat of 1931. The most common issues that have emerged from different literature on Van Panchayat are the eroding power of the Van Panchayat, litigations for a variety of reasons, like encroachment, conflicts between and within the communities, failure of collective efforts of villages and revenue department due to unfair distribution of benefits.

2. Joint Forest Management (JFM)

This has resulted in steady depletion of resources and led to the realization that without the willing and active support of the communities dependent/ living close it will not be possible to achieve the goal of sustainable forest management. The development of the Joint Forest Management program in India is based on the National Forest Policy, 1988 which emphasized the involvement of village communities living in and around the forest in protection and development of forests. In 1990, the subsequent notification was given by the Government of India to State Governments to involve local communities in forest management. To increase the participation of villagers in the Joint Forest Management, village-level organization (VLO) comprised of villagers are needed. Such an organization may be the existing village Panchayat itself or maybe a newly formed organization for the purpose such as a Cooperative Society, a Development Society or a Forest Protection Committee. Most of the VLOs were involved in the form of village forest protection committees in JFM. The formation of these Committees has been facilitated directly by the officials of the State Forest Departments as well as with the help of local non-government organizations.

Some of the important issues associated with the Joint Forest Management program are as follows:

- i. Delay in initial approval and signing of agreements by the Forest Department
- ii. The insecurity of tenure to people
- iii. Lack of people's participation in planning
- iv. Lack of cooperation between the NGOs associated and the Forest Department as well as between different VLOs.

(b) Governance by Civil Society: Cooperatives for Sustainable Development

The ideology of the cooperative approach is based on the principles of solidarity, mutual assistance, participation and empowerment of the community. The Dairy milk cooperative in Anand, Gujarat (AMUL) is considered a good example of cooperative which has resulted in resource management along with improving the quality of life of members of cooperatives and their families. Forestry activities have also been promoted by individual members of the civil society and their organizations on non-forest or farmlands. The main attempts taken in this category are Tree Growers Cooperatives on Revenue Wastelands and farm forestry on farmlands.

Tree Growers Cooperative Societies (TGCSs)

The National Dairy Development Board (NDDB) launched a pilot project in 1986 to establish tree growers' cooperatives on the pattern of Amul to meet the fuelwood and forage needs in

the rural areas. A two-tier structure was visualized for such cooperatives primary cooperatives at the level of a village or a cluster of villages and a federation at the level of a State (NDDB 1985).

The main objective of a primary cooperative has been stated as to improve the ecological-environmental status in general and to motivate members and village communities to grow trees and grasses of suitable species on marginal agricultural land, degraded forest land, wasteland, Revenue land, and common grazing land. The NDDB created a national-level apex organization, the Rashtriya Vriksha Mitra Sahyog Limited (RVMSL) to carry out the activities conducive to the socio-economic development of tree growers. The main functions of RVMSL are organizing effective production, procurement, processing and marketing of related commodities (RVMSL 1988).

Farm Forestry Cooperatives

As per India-Canada Environment Facility (ICEF) agreement, afforestation projects are implemented in multiple states and the Indian Farmers Fertiliser Cooperative (IFFCO) has promoted the Indian Farm Forestry Development Cooperative for these projects in Uttar Pradesh, Rajasthan, and Madhya Pradesh. It has been adopted at the individual as well as for corporate bodies. Farmers cultivate trees on their farmlands if this brings them higher income in comparison to other farm crops. The farmers have therefore also opted for contract farming of trees. Many corporate bodies are engaging farmers in contract farming of trees.

For example, BILT provides bank loans to needy farmers and purchases the pulpwood produce of farmers at declared support price or market price whichever is higher. Currently, BILT is operating in six states of India, namely, Tamilnadu, Haryana, Maharashtra, Andhra Pradesh, Orissa, and Chhattisgarh. There are many such bodies like WIMCO in Uttar Pradesh that practice contract farming of poplar with the farmers.

Community Forestry

Besides the above-mentioned efforts by the government and organizations, efforts of participatory forest management by the local communities have been found appreciative. They are maintaining the sustainable patches of forests for their socio-cultural beliefs/values and the supply of certain forest products and services on a sustainable basis. They have been found in a good number in states like Orissa, Chhattisgarh, Gujarat, and selected areas of north-east India.

Foreign Governance and Aid: Is it Root for Split Development?

The demands being made of Indian forest products today are more than ever before. Managing forests to provide for the environmental, cultural, social, and economic well-being of countries rapidly expanding the population, while conserving the resource for future generations, has become the most challenging task in the coming years. The challenge has increased due to the multiplicity of stakeholders who have conflicting expectations and demands. The aim of increasing forest cover in India from 19.39 percent (FSI estimate, 1999) to 25 percent by 2007 and 33 percent by 2012 is not easy to achieve without active participation and good governance.

India ushered in a landmark constitutional reform in favor of decentralization around the same time launched a major program on economic reform in the early 1990s. India's forest resource is under tremendous pressure. Forests meet nearly 40% of the country's energy needs and 30 percent of the fodder needs. Besides timber countless non- wood forest products are removed from forests for food, medicine, and another commercial purpose.

Besides, inadequate investment in the management of natural 66 forests was recognized as one of the major problems in reversing the deforestation rate. With the belief that external assistance will gear overall development of forestry sector will help the country to move fast in all-round development including poverty alleviation several foreign aided projects have been implemented in the country.

Trends in Forest Governance

Since the evolution of forest governance from command and control to networked governance, the following trends have been observed.

- i. The increasing involvement of non-state actors due to split development
- ii. Multi-scalar policy processes
- iii. The growing importance of market arrangements

i. The increasing involvement of non-state actors due to split development

Due to neoliberal reforms, the involvement of non-state actors is increased and the role of the state is reduced. Neo-liberal thinking promoted widely through Structural Adjustment Programmes imposed by the International Monetary Fund (IMF) and the World Bank recommends that tasks which used to be the responsibility of the state are transferred to private enterprises or are carried out jointly by governments and private sector companies in public-private partnerships. This has also influenced the practice of forest and natural resource management. The democratization wave (in the late twentieth century) paved the way for stronger participation of civil society organizations (CSOs) in the formation of forest policies and it stimulated the involvement of non-state actors in forest management. Massive sponsorship of civil society building by international donors in 70 the wake of the good governance debate led to a dramatic increase in the number of CSOs in the last decade of the twentieth century. An increasing number of these have formed alliances with both national and international actors to shape forest policies and management.

ii. Multi-scalar policy processes

Several factors have led to governance arrangements between actors operating at different geographic scales, ranging from local to global levels. Firstly, there is a worldwide trend towards decentralization, which includes de-concentration, delegation, and devolution, however, this trend is more pronounced in developing countries. "De-concentration is a process of downward extension of the administrative system by which administrative authority or responsibility is transferred from the national forestry administration to the provincial or district administrative level or municipal authorities" (Singhal, 2006). The delegation, or the outward extension of the administrative system, is the transfer of managerial responsibility to organizations indirectly controlled by the central government such as regional development agencies.

When devolution happens then decision-making powers are transferred from the government (central/state) to local actors, such as indigenous populations, local community organizations or organized groups of forest users. Currently, forest governance is being shared between central government, lower administrative levels, and CSOs. Moreover, globalization defined as the growing interconnectivity and interdependence between countries has led to multi-level governance. Globalization facilitates the rapid spread of ideas about good forest governance, sustainable forest management and corporate social responsibility combined with advanced information and communication technologies and fast means of transportation. As a result, actors operating at a global scale increasingly take part in forest governance at national and local levels through international treaties and partnerships with national or local governments, CSOs and local communities. These international treaties and multi-level partnerships for sustainable forest use and management often aim to reconcile local livelihood needs and global environmental concerns.

iii. The increased importance of marketing arrangements

Due to the remote and diverse location of forests in India and the lack of infrastructure, people living in forest areas traditionally were primarily engaged in subsistence-based livelihood activities in which forests played an important role. The remote forest areas have opened up in recent decades with the expectation of planned (resettlement especially from National park areas) and spontaneous migration and the extension of government-planned infrastructure. As a result, forest-dependent communities became integrated into commercial networks. This, in turn, allowed them to diversify their livelihood strategies beyond subsistence.

Two factors have created new market opportunities for forest products. First, commercial forest use expanded from timber to non-timber forest products and, to an increasing extent, ecological services such as watershed management, CO₂ sequestration, aesthetic services in the form of ecotourism. An increasing number of international 71 treaties (e.g. the Kyoto protocol) have created financial mechanisms governing the payment for ecological services. Secondly, the pressure from consumers for environmentally-friendly and socially-responsible production has caused an increasing number of private businesses to operate deliberately under the label of Corporate Social Responsibility. To obtain a green and socially-conscious image, these enterprises partnered with (indigenous) communities for the sustainable production of forest products and various other commodities that allows them to operate on profitable niche markets. These company-community partnerships also offer new marketing opportunities for communities living in and near tropical forests.

As a result of diversified commercial options, economic interests in forest governance are becoming increasingly important. Additional income-generating opportunities lead to an increase in illegal practices and corruption. This has added to the understanding that improved forest governance is urgently needed for safeguarding forests for human benefits.

To do Activity

- Group work – Visit nearby forest department office and prepare a detailed report of Forest governance and management practices followed in your area. Prepare a report of maximum 1000 words.
- Individual work- Identify various stakeholders in your area who are involved Forest governance or management. Also list down their roles and responsibilities. Prepare a report of not more than 500 words.

3.3 Joint Forest Management

Joint Forest Management is the concept of developing partnerships between the forest department and local forest protection communities. The partnership is based on mutual trust and jointly defined roles and responsibilities for forest development and protection.

Origin of Joint Forest Management (JFM) Programme

As per the provisions of national Forest Policy, 1988, a major policy decision was taken by the Central Government of India. The same was conveyed to State Governments to outline a framework for people's involvement in forest protection, conservation, and development of degraded forestlands. This gave birth to the JFM program. Under this programmed various village level organizations are formed. JFM paved a new path for truly empowering the local communities with decision-making powers and rights and responsibilities to manage forests so that forests can be used to satisfy their people's basic needs.

The Ministry of Environment and Forests (MoEF) issued policy guidelines for the village communities on June 1, 1990, under the JFM program. Regular evolution of the models based on local

socioeconomic conditions has resulted in the present strength of 1,06,482 such committees (22 million participants) in 28 States covering 22.02 million ha. of degraded forest lands in the country. The movement got institutional funding under the National Afforestation Programme (NAP) of the MoEF. Forest Development Agencies (FDAs) have been created at the district level to function as the link between MoEF and JFM Committees as part of NAP. The main functions are to scrutinize the projects; release funds and implement the sanctioned afforestation program. The concept of JFM is based on the concept of love and care.

Some guidelines were issued in 2000 and 2002 for strengthening JFM. These guidelines are as follows:

1. Joint Forest Management Committees (JFMCs) are registered under different names in different states. Many times, they do not have legal support. To provide them legal power, it has been decided that a uniform name i.e. JFMC should be registered under the Societies Registration Act, 1860.
2. A Memorandum of Understanding (MoU) to be signed between State Governments and the Committees. The roles and responsibilities are mentioned in MoU.
3. All adults of the villages are eligible and have an equal right to be part of JFMC.
4. At least 50 percent of members of the general body should be women. This has been decided after considering the immense potential and genuine need for woman's participation. The presence of at least 50 percent of women is a must for holding the general body meeting. In the Executive/management committee, 33 percent of the membership should be filled from amongst the women members. One of the posts of office bearer (i.e. President/Vice-president/Secretary) is reserved for a woman member of the committee.
5. JFM programme should cover degraded as well as good forests with a density of more than 40 percent. JFM activities should also concentrate on non-timber Forest Products (NTFP) management, their regeneration, and sustainable harvesting. A separate benefit-sharing mechanism for good and degraded forests.
6. JFMC is eligible for profit sharing for timber if it has protected the good forests for a minimum of 10 years. The sharing percentage is limited to a maximum of 20 percent of the revenue from the final sale.
7. New working plans for a JFM overlapping working circle with prescriptions, keeping in mind the health of the forest and the needs of the forest-dependent community. Participatory rural appraisal exercises should be conducted to develop micro plans at the local level. These plans should reflect the consumption and livelihood needs of the local community as well as the sustainability of resources.
8. Conflict resolution forums should be formed at various levels.
9. If there is any community that already exists and protecting the forests, it needs to be identified, recognized and registered as JFMCs.
10. Not less than 25 percent of the revenue earned from the final harvest should be deposited in the village development fund.
11. Concurrent monitoring of progress and performance at district and state levels.

Objectives of JFM

The primary objective of the JFM is to the sustainable use of forests in such a way that the needs of the locals will be fulfilled along with ensuring environmental sustainability.

Organizational Structure of JFM

There are two principal stakeholders in the JFM: The state as represented by the forest department (see Figure) and the community grouped in a collective decision body (Forest Protection Committee). The FPC is an executive body and delegated decision-making. FPC meets once or twice a year. An executive body is a subset of FPC and performs decision making. This body meets twice a

month to make decisions regarding the use and management of forests. The respective roles of the Forest Department, NGOs and FPCs are mentioned in the subsequent figure.

Note: FD=Forest Department

NGOs= Nongovernmental organizations

FPCs= Forest Protection Committees

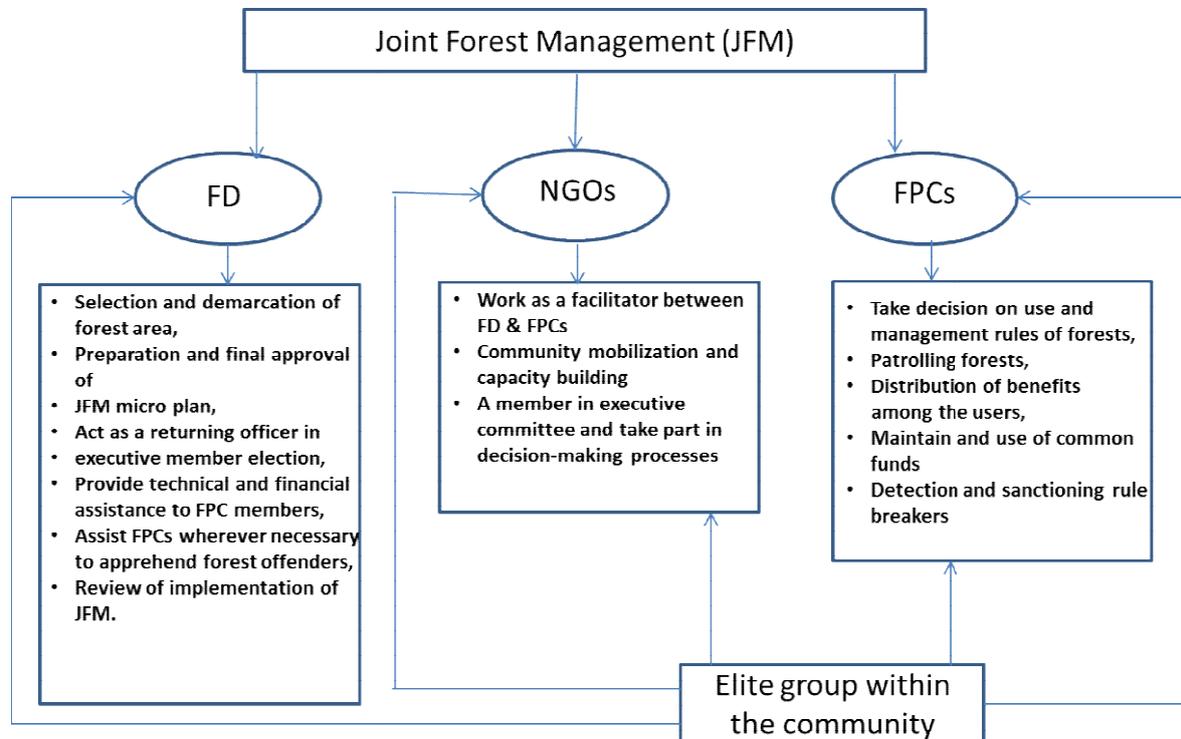


Figure 3-3 Organizational Structure of JFM³¹

Challenges in JFM Programme

Gender Issues in JFM Programme

Women in rural areas are a major force in forestry. Apart from gathering non-timber forest products, they can also participate as wage labourers in forestry work. Sal and Tendu leaves are two main NTFP cash earners. These are collected by women primarily. The role of women signifies that they have a symbiotic relationship with the forests. This important factor is often missed while designing various projects that are aimed at involving communities in forest conservation and management. Women's presence in decision making has left much room for improvement.

1. Arrangements for women in the JFM program

Under the National Forest Policy, 1988, the Government of India has specified that at least two women should be on every committee in the JFM program. The programs like JFM which aim to involve women as a lead actor should be sensitive to gender disparities and any constraints that would prevent women from participating as equal to men.

As per the guideline, women should constitute 50 percent of the membership of the general body and at least 33 percent of the JFM Executive Committee (EC). Also, the woman should hold at least one position of President, Vice-president or secretary. The quorum for holding

³¹ Source : https://www.researchgate.net/figure/The-Organizational-Structure-of-Joint-Forest-Management_fig1_253576584

meetings should be one-third of women executives' members or a minimum of one, whichever is more. The Forest Development Agency (FDA) which is a confederation of JFMCs at the forest division level should constitute 50 percent of the membership of the general body. In the executive body, 15 nominees from the JFMCs would include a minimum of 7 women.

2. Lack of Participation by Women in JFM

After making all the provisions for women reservations, various studies in rural India still show that village-level institutions under JFM are male-dominated and decisions are taken by them only. In some states, the participation of women is ruled out whereas in other states women's presence in JFMCs is secured essentially to fill the quota for women.

Some other reasons for lack of participation as follows:

1. Lack of information
2. Apprehension about the attitude of the Forest Department Staff
3. Family responsibilities solely carried out by women
4. Social and cultural restrictions
5. Lack of confidence
6. Lack of security
7. Lack of direct benefits
8. Lack of female staff in the Forest Department

Equity Issues in JFM

Forest dependent communities are diverse. Ignoring their heterogeneity can lead to wrong priorities and inequities. Various communities perceive forests in different ways. For most of the communities, forests are a source of livelihoods or free area available for grazing. Some communities also worship forests as a god. This creates intra and inter-community social inequalities because the social meaning (That communities perceive) differs from the legal rights that have been decided by the government.

Performance and Outcomes of JFM

There are various aspects based on which the performance and outcome of JFM can be analyzed. Three broad areas are

- (i) Institutional and Policy aspects; (ii) Forest regeneration and (iii) Livelihood Impact

Each area is discussed in detail below.

i. Institutional and Policy Aspects

JFM has been seen as a balanced framework from the policy point of view. The reason being, it is designed in such a way that it can reverse the injustices that have been meted out to the local communities. At the same time, JFM also gives sufficient control to Forest Department over the forests. National Forest Policy (NFP) ensures a backup mechanism to reverse state failures. NFP gives leadership and rights to the forest department to take action against the state government.

Thus, while JFM is designed as a progressive policy but it is still prone to political agendas of various states. JFM is constrained with the market forces that tend to take maximum benefit from forest products and forest bureaucracy.

ii. Forest Regeneration

Forest regeneration study on the impact of JFM during its early phase in Haryana reveals that people's involvement in protection led to a significant increase in tree density. This, in turn, led to increased green cover, reduced soil erosion and improves water conservation and fodder availability. The macro-level analysis of forests shows significant improvement in forest regeneration

since the launch of JFM. However, the micro-level analysis shows the limited impact of JFM on forest regeneration. The actual results are lower than the expected results.

iii. Livelihood Impact

The primary objective of JFM is to improve the socio-economic conditions of forest-dependent communities in the following ways.

- To serve as a source of fodder, fuel wood, and other forest products.
- To increase the employment opportunities for the poor by enhancing biomass production and collection of Non-Timber Forest Products (NTFPs).
- To improve the green cover that boosts the soil and water conditions which results in increasing farm productivity.

On the contrary, the restrictions imposed on forest-dependent communities can affect their livelihoods negatively. The livelihood impact assessment of JFM (Steering Committee Report, 2013-18) indicates mixed gains with the marginalized sections. As per the report, Forest Department and communities have been able to come together and income, employment, and NTFP availability seem to have improved for the poor. These improvements for the poor are significant but JFM has been failed in proactively incorporating the needs of the poor. In all cases of successful regeneration, those were better-off both directly and indirectly. The impact of improved resource conditions and diversification has been felt mainly by the landed and better-off groups.

JFMCs versus PRIs (Panchayat Raj Institutions)

In many northern and southern states, the JFM is dependent on government funding. Also, the institutionalization of the program in the country is highly uneven. The sustainability of JFM is in jeopardy because of the varied state-wise implementation of the program. As per the 73rd Amendment of 1993 and act of 1996 (Extension of Scheduled Areas), PRIs have a political mandate to look after social and farm forestry.

The state government has given the authority to devolve forest management to JFM committees (JFMCs). This is perceived as a challenge to the three-tier governance structure of India and the democratic decentralization. JFMCs require legitimacy to sustain in the long run. If more security is not provided to JFM tenures, Public interest and investment would remain sub-optimal. JFM institutions are continuously changing and evolving. There is no confirmed outcome that we have achieved so far. The expected outcomes out of JFM are as follows:

- All afforestation activities are taken up in a truly participatory JFM mode.
- JFM Institutions are empowered for decision making on all management aspects.
- Conflict management systems with social relevance must be developed.

With the current level of progress of JFM, it is not advisable to completely scrap the JFM program but there is the scope of improvement on policy and institutional aspect.

Scope of Improvements in Future

Major possible future directions for JFM have been identified based on the review attempted in this chapter. These include the following:

- (i) The legal backup for JFM needs to be increased so that JFMCs emerge as empowered institutions in the context of sustainability and enforcement of rights conferred on communities.
- (ii) The JFM platform should be able to help the poor exert their rights in case of future conflict over forests. Participatory approaches need to be extended even to dense forest areas.
- (iii) Ensuring autonomy both in the institutional design and planning process of JFM assumes importance given in diverse contexts in which JFM works.

- (iv) The local livelihood needs of the community must be addressed prominently with the help of such autonomy. Micro planning has to be necessarily integrated with the forest plans.
- (v) The JFMCs could continue either as user-based or wider community-based institutions tailored to local needs or contacts resolved through democratic processes involving local governance institutions.
- (vi) To ensure the participation of women and marginalized sections, JFM needs to be linked to Panchayat Raj institutions.
- (vii) Linkages with NGOs have to be strengthened for further capacity building and value addition to NTFPs. The state needs to allocate needs to resources to forestry and other natural resource regeneration programs so that they can reinforce the role of ecological security for poverty alleviation.
- (viii) The rights of JFMCs can be extended in their respective areas by converging them with wage employment and watershed programs and other conservation measures.

To conclude, while JFM has produced limited gains, there is a need for a people-centric approach in the future.

To Summarise

JFM is unique and innovative in many ways although the outcomes of the program are never confirmed rather visualized. JFM has remained top-down because of systematic and programmatic barriers and limited in its scope and transformational impact. The macro impact of increased forest cover both quantitatively and qualitatively has been very modest since the launch of JFM. Limited resource allocation and donor dependence are few other macro constraints. At the policy level, JFM has been able to create on paper commitments which are distant from reality. JFM proved to be incapable of pushing in a more empowered devolution for forest conservation by communities. The People's institutions have suffered due to the absence of autonomy and legal backup under JFM. At the micro-level, JFM has identified the potential areas that can be tapped for more success. The possibility of employment and livelihood is acting as an incentive for the poor and forest-dependent communities to work for forest regeneration.

To Do Activity

- Group work – Prepare a report on the analysis of how various states have adopted the Joint Forest Management (JFM). Prepare a short 5-minute presentation on any village that has adopted JFM. Organize the class into groups of 5.
- Individual work – Report the improvements in forest management and increase in forest cover after adopting JFM. Prepare a report of maximum 500 words.

3.4 Sustainable Forest Resource Management Strategies in India

India possesses around 2.5% of the world's land area with 1.85% of total forest area. It has to serve the needs of 17% of the world's population and 18% of the total livestock population. Due to the impact of population growth and climate change, there is a threat to the forest cover and it has become imperative to preserve forest and sustainable forest management is needed.

Economic Aspect of Sustainable Forest Management

There is a constant threat to the forest cover as forest products are an important part of the Indian economy and there are major uses of the wood and non-wood products from forests that are used. In India, the paper industry and furniture industry are the main consumers of wood along with that India are the largest consumer of fuel wood. India also produces non-wood forest products such as latex, gum, essential oils, medicinal plants, resins, etc. Non-wood forest-based products provide supplementary income to 50% of the rural population. Hence, there arises the need to sustainably manage forest resources.

Sustainable Forest Resource Management

Tenth Five year Plan suggested a greening India program for taking up afforestation and agro forestry through an integrated program. Considering the efforts of greening outside the area under the Forest Department and that irrespective of recorded land use and ownership status, there are about 553 lakh ha wastelands that exist. The scope of optimizing productivity in cultivable areas is the topmost priority for Government.

Greening India Mission (GIM)

The National Mission for a Green India, which is one of the eight Missions under the National Action Plan on Climate Change (NAPCC), recognizes the adverse impacts of climate change on the distribution, type and quality of natural biological resources of the country and associated livelihoods of the people.

The Mission also referred to as GIM, recognizes the importance of forestry sector and its role in environmental amelioration through climate mitigation, food security, water security, biodiversity conservation and livelihood security of forest-dependent communities. GIM puts “greening” in the context of climate change adaptation and mitigation. Greening is meant to enhance the ecosystem services such as carbon sequestration and storage (in forests and other ecosystems), hydrological services and biodiversity; as well as other provisioning services such as fuel, fodder, small timber and non-timber forest products (NTFPs). GIM aims to cover about 10 million hectares under different Sub-missions at a cost of Rs. 34,000 Crores during the period 2011-2020.

The Mission aims at responding to climate change by a combination of adaptation and mitigation measures, which would help in:

1. Enhancing carbon sinks in sustainably managed forests and other ecosystems
2. Adaptation of vulnerable species/ecosystems to the changing climate
3. Adaptation of forest-dependent communities.

Agro-Forestry and Social Forestry

Agroforestry and Farm forestry have been promoted earlier as a way of sustainable management of forest resources. As per the provisions of National Forest Policy, the industry and farm sector can grow industrial raw materials in mutual collaboration, and this has tremendously increased the scope of Agro and farm forestry. The efforts for creating an enabling environment for agroforestry as an enterprising supplement to agriculture were limited to regulations for timber transit in the States. In most of the States, common agroforestry species are exempted from transit regulations.

Plantations in Government forest lands have discouraged the farm sector from agroforestry because growing the same crops in forest land has resulted in reduced size of markets for farmers. The lack of market incentives, promoting fair trade and networking enterprises has resulted in no progress in this direction. Agroforestry may hurt local biodiversity and on the livelihoods of people (mostly the poorest) who depend on common lands; the Eleventh Five year Plan ensured that such plantations are not promoted on common lands. Social forestry was initiated in the 1980s to assist rural communities to meet their livelihood needs for fuel wood, small timber, fodder and minor forest produce through community-planned and managed tree plantations and nurseries. Social forestry has been included as a Panchayat subject in the law.

Agro Forestry

Agro forestry means the practice of agriculture and forestry on the same piece of land. This is a sustainable management system for land and it also increases overall production by combining crops and animals simultaneously. It also connotes a land-use system that integrates trees, crops, and animals in a way that is ecological, desirable, practically feasible and socially acceptable to the farmers. Agro forestry is a collective name for all land-use systems and practices where crops and trees are grown on the same piece of land in some form of special arrangement or temporal sequence.

Advantages of Agro-Forestry

With the increasing pressure on the forest due to an increase in demand in India, forests are unable to fulfil the demand. Forest even at the optimum level of conservation and productivity would not be able to fulfil the requirements. Agro forestry is the only segment that can help in growth in production. Forest products like Timber, fuel wood, industrial wood fodder, grass, and medicinal plants can be grown along with the crops on the same piece of land. In this manner, farmers get remunerative returns and their income will also increase. Timber and firewood produced under Agro forestry can meet the local demands in the rural areas. This will solve the expenditure and problems related to the transport of wood. The productivity of Agro forestry plantations is much higher than natural plantations. It will also generate substantial employment in rural areas. Timber can be processed and can be used as sewing, joinery, furniture making, etc. Agro forestry provides insurance against risk caused by weather aberrations and it ensures sustainable production on the land. Following are the benefits of Agro forestry:

1. Improvement in soil fertility which will increase the crop yield
2. Reduction in soil erosion
3. Meeting the demand of fuel fodder and timber for the increasing population
4. Reduction in biotic pressure on existing forests

Constraints of Agro Forestry

Considering the vast forest cover in India, it is impossible to conduct Agro forestry. The most important reasons, which are preventing from practicing Agro forestry in India, are listed below:

1. Lack of appropriate infrastructure at the ground level for generating data on Agro forestry area production and prices of a particular region.
2. Lack of adequate policy and awareness on the part of farmers.
3. Highly imperfect market.

Strategy for Agro Forestry Popularity

In India, agricultural departments, research centres and universities can play an important role in spreading awareness about Agro forestry among the farmers. However, these institutions have been preoccupied with crops and enhancing the impetus of the Green Revolution. But there is a chance to give more attention to Agro forestry now because this will solve many problems all together. All these institutions can provide guidance and support to the farmers who are willing to involve in Agro forestry. The forest departments must produce seedlings and provide these to the farmers along with the technical inputs. Forest Department can also provide the market linkage for the Agro forestry products. Expansion of Agro forestry will require extensive support of good quality input stock and marketing support and above all removal of restrictions on harvesting and sale of trees and Timber. The implementation will require bringing behavioural changes among farmers. The combined effort of various agricultural-based institutions and the Forest Department can make Agro forestry practice successful in India.

Social Forestry

Social forestry was first recognized as an important component of forestry in the interim report of the National Commission on Agriculture (NCA), 1972. The notion behind adopting social forestry was to fulfil the basic and economical needs of the community. The first five-year plan indicated scope for the establishment of village plantations and a series of government-aided social Forestry projects during 1980. The scope of social Forestry includes farm forestry, community woodlots, and reforestation in degraded lands. Social forestry is forestry for the people with the people and by people and by the people. The National Commission on agriculture issued the guidelines for tree plantation under social forestry.

1. Increase in the production of fuel wood, small timber, and leaf fodder
2. Releasing cow dung for use as manure

3. Creating a diverse ecosystem by having trees interspersed with cultivation to create windbreaks.

This interim report suggested reforestation of degraded forest for the following objectives

1. Growing short-rotation fuel and Timber species for meeting fuel requirements
2. Ensuring fuel wood supplies at reasonable rates
3. Prevent stalking of fuel wood by anyone dealer

Critics of Social Forestry

Social forestry is highly criticized for creating inequality in society. By and large social Forestry benefits the relatively richer households while those having no land were left to starve. The **products** obtained from the forests are used differently by the different categories of the society. The upper class will support producing cash crops because they have a high market value whereas for farmers the rational choice to plant trees is to get fuel wood and fodder.

Criteria and Indicator Approach

The agro forestry and social forestry may not sustain in the long run. Therefore, there is a need to shift focus from forestry-based approach to an approach that covers social, economic and sustainable dimensions of forest management. There are many internationally accepted approaches such as lifecycle approach, impact assessment, and cost-benefit analysis. A simple forest cover is not sufficient to provide a solution to the problem holistically. Considering all the facets of the problem, criteria and indicator approach have become popular in recent years and it is a widely accepted approach in which criteria cover the aspects of sustainability and each criterion has certain indicators that can help in scaling the magnitude of the changes. In December 1999, one criterion and indicator-based approach were adopted in Bhopal, commonly known as the Bhopal-India process. A total of 8 criteria and 49 indicators were identified and adopted.

Table 3.3 Criteria and indicator approach

Criterion	Indicator
Increase in forest and tree cover	<ul style="list-style-type: none"> • Area and type of forest cover under natural and man-made forests(tree plantations) • Forest area officially diverted for non-forestry purposes • Forest area under encroachment
Maintenance, conservation, and enhancement of biodiversity	<ul style="list-style-type: none"> • Area of protected ecosystems (protected areas) • Number of Animal and plant species and number and status of threatened species
Maintenance and enhancement of ecosystem function and vitality	<ul style="list-style-type: none"> • Status of natural regeneration Incidence of forest fire • The extent of livestock grazing Forest area open for grazing • Number of livestock grazing in the forest
Conservation and maintenance of soil and water resources	<ul style="list-style-type: none"> • Conservation and maintenance of soil and water resources • Area prone to soil erosion and area under a ravine, saline, alkaline soils and deserts (hot and cold)
Maintenance and enhancement of forest resource productivity	<ul style="list-style-type: none"> • The growing stock of wood Increment in the volume of identified species of wood • Efforts towards enhancement of forest productivity and Technological inputs
Optimization of forest resources utilization	<ul style="list-style-type: none"> • Recorded removal of wood and recorded collection of non-wood forest produce • Aggregate and per capita consumption of wood and non-wood forest produce
Maintenance and enhancement of social, cultural and spiritual benefits	<ul style="list-style-type: none"> • Number of Joint Forest Management committees and area(s) protected by them • Degree of people's participation in management and benefit-sharing • Level of participation of women.
Adequacy of policy, legal and institutional framework	<ul style="list-style-type: none"> • Existence of policy and legal framework • Number of forest-related offenses • Level of investment in research and development

Forest Produces Dependent Livelihoods

Forests are the producers of various products and also the protectors of several natural resources. Timber and pulp are the chief economic products of forests. The economic benefits of forest are recognized in terms of climate control, pollution reduction and Wildlife Protection. Forest produce

can be divided into several categories. From usage, it can be categorized into two types: Timber and Non-timber Forest Produce (NTFP).

Table 3.4 List of Forest produce and dependent livelihoods

Type of Livelihood	Forest produce used	Forest produce income as part of total income
Fuel-wood sellers	Timber	High
Small-scale loggers	Timber	High
Furniture wood seller	Timber	High
Woodcarvers	Timber	High
Paper seller	Timber	High
Gum selling	NTFP	High to moderate
Essential Oils seller	NTFP	High to moderate
Resin seller	NTFP	High to moderate
Food/fruits/flowers	NTFP	Low
Medicinal plant seller	NTFP	Moderate to low

As it is observed from the table, Timber based livelihoods always produce high income as part of total income whereas Non-timber-based forest produce can yield income from moderate to low. However, in India, NTFPS is associated with the cultural and socio-economic life of forest-dependent communities. The NTFPs serve as a vital livelihood safety net in times of hardship. NTFP provides substantial inputs to the forest-dependent population especially those who have limited agricultural income. NTFP is a major source of livelihood and income for forest dwellers.

To Do Activity

- Group work – Prepare a detailed report on any one non-timber forest produce (NTFP) produced in India. Also mentions its market demand and scope of future improvement in production of the NTFP. Prepare a short 5-minute presentation of not more than 10 slides. Organize the class into groups of 5.
- Individual work – Prepare a report on Bhopal-India process.

3.5 Government Policies and Institutional Support

Government Policies and Interventions

The well decided policies and interventions related to forests were enunciated in the pre-independence era. These were formulated by the British and later evolved in post-independence time. The policies were designed on the national and state level.

1. Pre-Independence Forest Policy

In India, forest-based public policy was first enunciated in 1894. The aim was to regulate the use of forest land under state control for public benefit.

History of Forest Legislation in India

Forest Acts of 1865 and 1878

Before enacting the comprehensive Forest Act, the 1865 forest act was made by British India. These acts mainly focused on the protection of trees, prohibitions on cultivation, grazing and deforestation in forest areas. This act was later revised in 1878. The revised act was extended to most Provinces of British India.

Indian Forest Act, 1927

This was the most comprehensive act and also different from other acts. This act enabled provisions to make rules and regulations unlike other acts of that time. This unique provision allowed the

Central Act to continue with the subject 'Forest' in Provincial Governments. The act covered subjects as Village forests, reserved forests, protected forests and control of timber, cattle trespass, forest officers and other related penalties for forests. This act is still in operation. National Forest Commission (Chairman), 2006 had recommended revamping this act as per the current requirements. The current Forest act should also emphasize on Forestlands along with forest and the role of community in managing Forests.

National Forest Policy (NFP), 1894

After the establishment of a structured forestry act in 1864, the first National Forest Policy was formulated by the British in 1894. This policy was defined for the first time to control and regulated the use of forests by forest-dependent communities. As per NFP, 1894, forests were declared state property and broadly classified under 4 headings:

1. Forest for preservation
2. Forest for commercial purposes
3. Minor forests
4. Pasture lands

This policy aimed to manage state forest for public benefit, certain regulation of rights and restriction of privileges for the use of the forest by the neighbouring populations was provided in this policy. NFP also clarified that all attempts are made for the full and easy satisfaction of the needs of forest-dependent people. There would not be any restrictions on the local demands nearly to increase the revenue. Supply of fuel wood was not an issue at the time. The government was of the view that the demand for fuel wood could be easily met from the margins of forest tracks without causing much harm to the valuable timber species. To conclude, NSP made it clear that claims of cultivation are stronger than the claims of forest preservation.

2. Post-Independence Forest Policy Developments

Central Government is taking policy initiatives in the forestry sector. The requirement is forestry is not defined and incidental. To address the requirement, the Government has set up from time to time, several commissions to give recommendations on various issues about forestry.

- a. Forest Policy 1952, 1988
- b. Indian Board of Wildlife, 1952
- c. National Commission on Agriculture (NCA), 1976
- d. Committee on Forests and Tribals, 1980
- e. Committee on Action Plan for Forestry Sector for Next 20 years, 1998
- f. National Forest Commission, 2006

Forest Policy 1952 and 1988

After independence in 1947, the forest policy 1894 was replaced by the forest policy 1952. Then new policy envisaged evolving a system of land use under which different types of land would be allotted to different users to lead to optimal production without degrading its worth. Forest policy was intended to increase revenue for the state. Production of timber Industries, Railways, markets, sports and defence needs were National interest which was to be accorded priority over domestic and agricultural needs. Forest policy 1952 for the first time recommended the promotion of tree planting by farmers on their Lands for the supply of their needs including fuel wood.

In 1988, the Government of India formulated the new forest policy as per the newly arising problems and Recommendations. Basic objectives of forest policy are as follows

- a. Maintaining the environmental stability through preservation and restoration of ecological balance
- b. Conserving the natural heritage of the country dry preserving the remaining natural forest with the vast variety of flora and fauna

- c. Checking soil erosion and extension of dunes in the desert areas. Increasing the sustainability of forest cover through massive afforestation and social forestry programs.
- d. Creating a massive people's movement involving women for achieving these goals and to minimize pressure on existing forests

3. Provisions and Legal Frameworks for Forests

As part of the natural environment and life support system, the forest has engaged the attention of all sections of society. The constitution of India has given due recognition to forest and wildlife. The two most important acts of the Indian Forest Act (already explained) and the Forest Conservation Act.

a. Forest Conservation Act, 1980

This act was enacted to check the indiscriminate diversion of forest land. Under this legislation, the Central Government's approval is required before any forest land is diverted for non-Forestry purposes. This act is the most important tool for the Government of India to control and regulate the change in the land use of forest land. As per Section 2 of the act, prior approval of the Central Government is necessary before a State Government or any other authority issues direction for cutting of reserved forests (reserved under the Indian Forest Act 1927), assigning forest land by way of lease, use of forest land for non-forest purpose or otherwise to any private person or any authority, corporation, agency or any other organization not owned, managed or controlled by the government and clear felling of naturally grown trees. Whoever contravenes or abets the contravention of any of the provisions of Section 2, shall be punishable with simple imprisonment for a period, which may extend to fifteen days.

1992 Amendment in the Forest Act

This amendment made provisions for allowing some non-forest activities in forests such as the setting of transmission lines, seismic surveys, conducting drilling and hydroelectric projects, etc with prior approval of Central Govt.

Institutional Support in India

There exist many institutions at the national and state level to support the State Forest Departments (SFDs). It is difficult for State/union territories to administer and manage efficiently in isolation.

1. National Level Forest Institutions

Several training and research institutes and support programs exist at the national level to help state governments to manage their forests.

- 1.1 Indira Gandhi National Forest Academy (IGNFA), Dehradun
- 1.2 Directorate of Forest Education (DFE), Dehradun
- 1.3 Forest Survey of India (FSI), Dehradun
- 1.4 G.B. Pant Institute of Himalayan Environment and Development (GBPIHED), Kosi-Katarmal, Almora
- 1.5 Indian Council of Forestry and Education (ICFRE), Dehradun
- 1.6 Indian Institute of Forest Management (IIFM), Bhopal
- 1.7 Andaman and Nicobar Islands Forest and Plantation Development Corporation Ltd (ANIFPDCL)

1.1 Indira Gandhi National Forest Academy (IGNFA), Dehradun

IGNFA earlier functioned as Indian Forest College from 1938 to 1987 train officers of the forest services in India. The college later upgraded and named Indira Gandhi National Forest Academy (IGNFA).

Training courses conducted by IGNFA:

- a. Forestry Induction training for IFS probationers

- b. Professional skill up-gradation for State Forest Service officers into the IFS
- c. Advanced Forest Management (AFM) courses for the IFS officers in their 10th, 17th and 21st year of service
- d. Workshops for emerging issues in forestry, wildlife, and environment

1.2 Directorate of Forest Education (DFE), Dehradun

After the creation of the Indian Council of Forestry Research and Education (ICFRE) under the MoEF, DFE was de-linked from the Forest Research Colleges. It functions under the direct administrative control of DFE. DFE is responsible for:

- a. Conducting induction training for the direct recruits to the State Forest Service (SFS)
- b. Conducting in-service training for SFS officers and FROs

At present, there are 3 SFS colleges at Burnihat, Coimbatore, and Dehradun and one Forest Rangers College, named as Eastern Forest Rangers College.

1.3 Forest Survey of India (FSI), Dehradun

FSI is a national level organization for forest resource assessment under MoEF, Government of India. Major activities of FSI include (a) Forest and tree cover assessment and (b) estimation of growing stock of wood within and outside of forests of the country.

Objectives of FSI:

- a. Assess forest cover of the country through Remote Sensing technology
- b. Conduct inventory in forests and non-forest areas at the national level and develop a database on wood volume
- c. Function as the nodal agency for collection, compilation, and storage of forest resources
- d. Conduct training and strengthen the research and development infrastructure

1.4 Indian Council of Forestry Research and Education (ICFRE), Dehradun

ICFRE is the apex body in the National Forestry research system and it has under it several research institutes and research centres. ICFRE supports solution-based forestry research.

Main objectives of ICFRE are:

- a. Undertake, aid and promote forestry education
- b. Develop and maintain a national library and information centre for forestry and allied sciences
- c. Acts as a collating-house for research and general information related to forests and wildlife

2. State Level Forest Institutions

2.1 State Forest Training Schools, Academics, and Institutes (SFDs)

SFDs are having training schools for imparting induction as well as refresher training courses to the frontline staff. States also have Forest Ranger College.

2.2 Forest Development Corporations (FDCs)

State governments established various FDCs to cater to the needs of forest-based industries, to undertake agro forestry and to take care of marketing strategies.

2.3 State Forest Research Institutes

Only 7 states in India have established their forest research institutes which research local-specific forestry and wildlife issues as it is not possible for ICFRE to control this.

3. Forest Research

The research in the forest department is organized with the establishment of the Imperial Forest Research Institute (IFRI) in Dehradun. The facilities are upgraded regularly. Different research centres were also established in Coimbatore, Bangalore, Jabalpur and other places.

These are reviewed from time to time by the Government of India. The separate council is established for governing forestry research and education. It is named as the Indian Council of Forestry Research and Education (ICFRE) in 1987. The mission of the ICFRE is “to generate, disseminate, preserve, technologies and solutions for addressing issues arising out of interactions between people and forests and environment on a sustained basis through education, research, and extension.” ICFRE fills the gap of research needs of forest engineering, wood anatomy, and disciplines of forest genetics. These issues are difficult to solve without having a dedicated research centre for the same.

3.1 National Research Needs

In the National Forest Policy (NFP), the priority areas of research and development have been identified.

Objectives of NFP:

- a. Increasing the productivity of wood and other forest produce per unit of area and per unit time
- b. Re vegetation of barren lands and watershed areas
- c. Effective conservation and management of existing forest resources, mainly natural forest ecosystem, etc.

3.2 International Research Needs

The rise in environmental problems such as global warming, desertification, pollution, etc gave rise to the need for International research. In the Rio Conference, International Forestry Research Organization (IFRO) has identified the following forestry research priorities on an international basis:

- a. Cause of deforestation
- b. Forest degradation and poverty in forest margin
- c. Landscape conservation and management of forest ecosystem
- d. Multiple resource management of natural forests
- e. Agro forestry research under natural resource strategies and policy

4. Forest Administration

4.1 Indian Forest Service

The forest department was created in November 1864 and Dietrich Brandis was appointed as the first Inspector General of Forests (IGF). The need for the administration of forests was realized with the exploit forests for the construction of railways and other requirements. Initially, police, army or other officers appointed in Public services were appointed for forest services. Indian Forest Services was created and its first batch was deputed for training to France and Germany in 1867 and later in the United Kingdom. When nationalisation of the IFS happened in 1922, 40 percent of the vacancies were reserved for Indians. One time recruitment of 178 officers took place in 5 years (1921-25). The recruitment discontinued in 1930.

After independence, the IFS were constituted in 1966. The recruitment is done by the Central Government but each state has a separate cadre. In some states and Union Territories, joint cadres exist.

4.2 Provincial Forest Service

The Provincial Forest Service (PFS) was created in 1891 after the formation of IFS to provide a link between the IFS and the government operations. Initially, the existing forest officers are promoted to this post with honour. Direct recruitment to this service was started in 1905 and training for PFS was started in 1906 at the Imperial Forest College, Dehradun. The recruitments were done by Provincial Governments. After 1947, the State Forest Services (SFS) came into

existence. After the recreation of IFS, the training for SFS continued in SFS colleges under the Government of India.

To do Activity

- Group work – Pick any one institution which is extending support to forest and present its objectives, functions and how the respective institute is established. Prepare a short 5-minute presentation of not more than 10 slides. Organize the class into groups of 5.
- Individual work – Prepare a report on any International organization which works for forest conservation. Prepare a report of maximum 1000 words.

Summary of the Chapter

The chapter discussed the forest resources in India in terms of its coverage, uses and the benefits that people get from forests. The chapter further discussed the Finance governance. The three-tier structure of forest governance at Central, state, and village are discussed in detail. The Green India mission is also explained in the context of measures to combat climate change. The unique forest management approach i.e. Joint Forest Management and its impact were discussed. JFM is not that effective in terms of the increase in forest cover. Also, gender issues and equality issues are prevalent with JFM. As a result, sustainable management practices in terms of agro forestry and social forestry were adopted. These practices empower the forest-dependent community. In the end, the pre-independence and post-independence policies were discussed. The pre-independence policies were more focused on consumer whereas the post-independence policies are designed in a manner to deal with the true problems. Institutions and research centres are present at the district and state levels.

Model Questions

1. What is forest and what is the forest coverage in India?
2. Describe different kinds of forests on the basis of area density and types of forest trees.
3. Explain the ecological and economic importance of forests.
4. What is Deforestation? What are its causes and effect?
5. Explain the Forest Conservation Act in detail.
6. What is Forest Governance? Explain forest governance in India.
7. What are the latest trends in forest governance?
8. What major step was taken by Government of India to forests to combat with climate change?
9. What is Joint Forest Management System? What are the guidelines to strengthen the JFM?
10. Explain the issues in JFM.
11. What is the performance and outcome of JFM?
12. After reading the chapter, kindly suggest possible future directions for JFM.
13. Explain Agro Forestry and Social forestry, the notion behind them and the problems with both practices.
14. In how many different ways various forest resources can be utilized?
15. Explain the main government policies related to forest for pre and post-independence era.
16. What are the main Forest institutions at national and state level? How these institutions are formed?

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Chapter 4 Energy Resource Management

Introduction

This chapter on energy resource management is about explicating the global energy scenario with a special focus on effective and efficient usage of different types of energies. The emphasis is given on explaining types and forms of energy, defining energy management so that it could be used in a most productive manner. In today's scenario where the consumption of energy is increasing at an unprecedented rate, it has become highly inevitable to shift from conventional energy sources to unconventional energy sources. Conventional energy sources like oil, coal, etc. cause pollution leading to environmental degradation, health issues, etc. Thus, international organizations and governments have come up with various institutes and policies to tackle this ever-growing problem of over and inefficient usage of energy resources. This chapter provides an in-depth understanding of various forms of energies and techniques of using them efficiently and the acts and policies regulating their usage.

Objectives

- To explain different forms of energies
- To familiarise the importance of energy conservation and energy efficiency,
- To provide insights on energy action planning at organization
- To comprehend on the use of alternative energy
- To familiarise rules and regulations associated with the energy sector.

Chapter Structure



4.1 Energy Resource: An Introduction

Energy is the capacity to perform work and all processes of life depend on it. Energy is an essential component for the survival of humans on this planet. An energy resource is something that causes the production of heat, electricity, displacement of objects as well as power life. Human consumption of energy has grown at an unprecedented rate over the year. The consumption of energy by early humans had a modest energy requirement, mostly related to food and fuel for the fire to cook and keep themselves warm. In today's era, the consumption of energy has grown

manifold. Fuel is the matter that stores energy. Most of the energy that is used comes from fossil fuel. Fossil fuel is the natural fuel such as coal and gas that is formed in the geological past from the remains of the living organisms. But fossil fuel, a non-renewable resource, is limited in terms of quantity as well as cause potentially harmful effects on the environment.

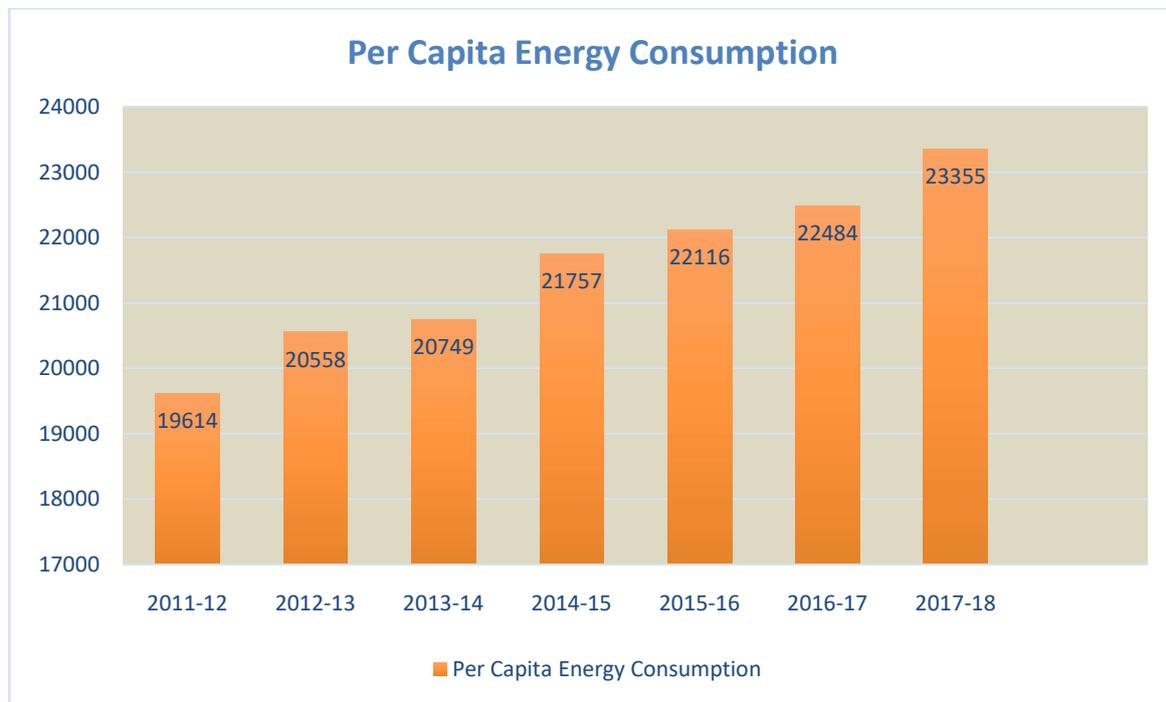


Figure 4-1 per capita energy consumption from 2011-12 to 2017-18³²

The figure 5.1 shows the per capita energy consumption increased from 19,614 Mega joules in 2011-12 to 23,355 Mega joules in 2017-18, the annual increase in PEC for 2017-18 over 2016-17 was 3.87%. Per-capita Energy Consumption (PEC) over a year is calculated as the ratio of the estimate of total energy consumption over the year to the mid-year population of the same year.

Major and Subsidiary Sources of Energy

Major energy sources can be classified into following:

- primary and secondary Energy
- commercial and non-commercial Energy
- renewable and non-renewable

Primary and Secondary Energy

Primary energy is the energy sources that are available naturally. For example, coal, nuclear energy (from radioactive substances), natural gas, and thermal energy stored in earth's interior parts. Secondary energy is the energy sources that are artificially produced using primary energy sources. For example, electricity produced from petroleum and coal, and electricity produced from nuclear energy.

Commercial and Non-commercial Energy

Commercial Energy sources that can be obtained from the market at a definite price are termed as commercial energy sources. These include electricity, coal, and redefined petroleum product. These energy sources form the basis of agricultural, industrial, commercial and transport development. These are not only used for economic production but also for household purposes.

³²Source: *mopsi.gov.in*

Non-commercial Energy sources are the sources that are not available in the commercial market at any price. These include agro-waste in rural areas, firewood, and animal power for transportation, lift water irrigation, etc.

Renewable and Non-Renewable

Renewable Energy sources are the sources that are inexhaustible in nature. These include wind energy, solar energy, and geothermal energy, tidal and hydroelectric energy. It does not release any harmful pollutants when harnessed thus making it a clean energy source. The non-renewable source is the conventional source of energy obtained from fossil fuels which are exhaustible. These include coal, natural gas, oil, and nuclear energy.

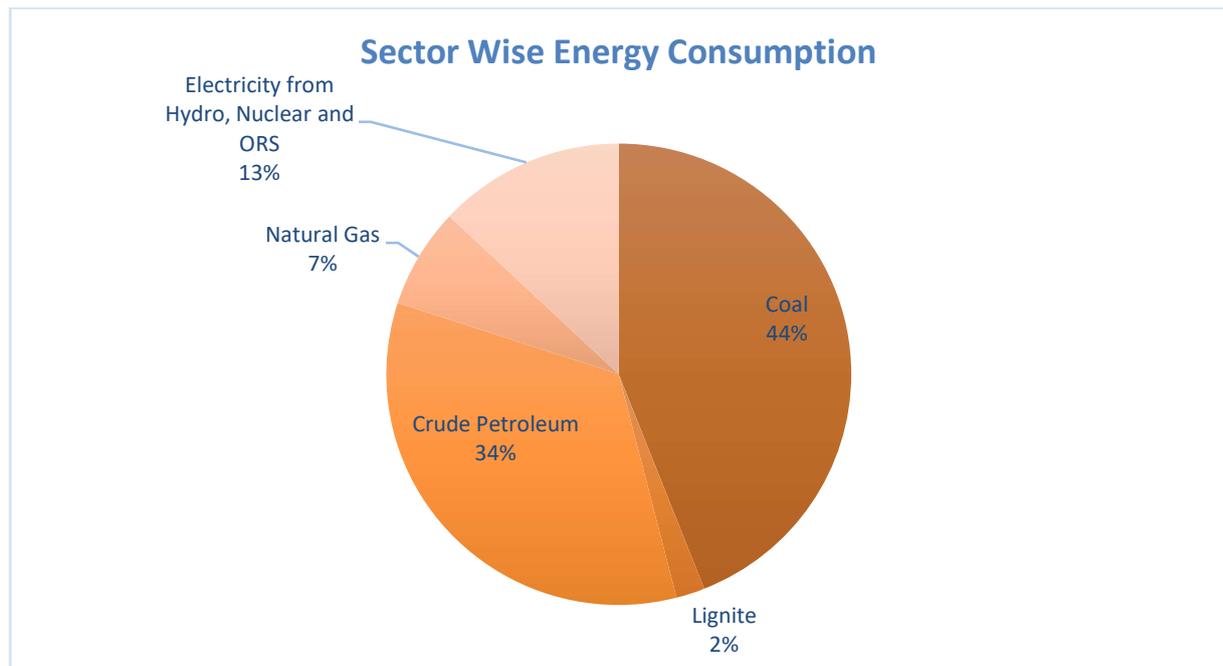


Figure 4-2 Source wise consumption of energy in India (2017-18)³³

The consumption of energy in petajoules in the form of Coal and Lignite was highest which accounted for about 44.1% of the total consumption during 2017-18. Crude Oil was second (34.32%), while Electricity (13.24%) was in third position.

Global Reserves of Primary Energy

Coal

World coal reserves in 2018 were 1055 billion tonnes and are heavily concentrated in just a few countries: US (24%), Russia (15%), Australia (14%) and China (13%) - India being the fourth in the list with 7.9%. (Source: BP Statistical Review of World Energy, 2019). World's coal production decreased 0.6 % in 2014 and a further 2.8% in 2015. This is the first ever decline in global production growth of coal since the 1990s. Coal still provides supply of around 40% of the world's electricity. Nevertheless, the demands for climate change mitigation, the transition to cleaner energy forms and increased competition from other resources present challenges for the industry. [1] Asia is the largest market for coal and currently accounts for 66% of global coal consumption.

³³Source: mopsi.gov.in

Oil

The global proven reserve of oil was estimated to be 1147 billion barrels at the end of 2003. Saudi Arabia had the largest share (23%) of the oil reserves. (1 barrel= Approx. 160Ltr). In 2018, there was 1.73 trillion barrel of oil in the world. That's enough to last another 50 years since the world uses 95 million barrels per day (Source: thebalance.com). Oil still is the world's leading fuel, accounting for global energy consumption (32.9%). Crude oil prices have registered the largest percentage decline since 1986 (73 per cent).

Approximately 63% of oil consumption comes from the transport sector. Oil replacement is not yet inevitable and is not expected to reach more than 5% over the next five years. Unconventional oil production accounts for 30% of the world's recoverable oil reserves, and oil shale contains at least three times the as much oil as conventional crude oil reserves, which are estimated to be around 1.2 trillion barrels.

Gas

The global proven gas reserve was estimated to be 196.9 trillion cubic meters by the end of 2018. With almost 19.8 per cent, the Russian Federation had the largest share of the reserve (Source: BP Statistical Review of World Energy, 2019). Natural gas is the second largest energy source in the generation of electricity, accounting for 22 per cent of the world's energy generation and the only fossil fuel whose share of primary energy consumption is projected to grow.

Uranium and Nuclear

Global uranium production increased by 40% between 2004 and 2013, mostly due to increased output by Kazakhstan, the world's leading producer. As of December 2015, 65 nuclear reactors with a total capacity of 64 GW were under construction. Two thirds (44) of the units under construction are located in three countries: China, India and Russia. There are currently more than 45 small modular reactors under development and four reactors under operation. (Source: World Energy Council, 2016)

Energy Needs of Developing Economy

Economic growth is desirable for developing countries, and energy is a crucial requirement of economic growth. However, the relationship between economic growth and increased energy demand is not always linear. For example, under current conditions, an increase of 6% in India's Gross Domestic Product (GDP) would impose an increase in demand of 9% on its energy sector. Thus, in this context, the ratio of energy demand to GDP is a useful indicator. A high ratio reflects energy dependence and strong energy influence on GDP growth. Developed countries, by focusing on energy efficiency and lower energy-intensive routes, keep their energy to GDP ratios below 1. The proportions are much higher for developing countries.

Per-capita energy consumption of India has increased by 7.1% from 2003 to 2013 (Source: Wikipedia). It is expected that it will continue growing due to the ever-increasing demand for energy in developing countries. And this growing energy demand is met by limited primary resources available. These resources are not only non-replenishable but also cause damage to the environment.

Energy and Environment

The use of energy resources in manufacturing causes environmental damage by polluting the atmosphere. Some sources of air pollution include sulphur dioxide (SO₂), nitrous oxide (NO_x) and carbon monoxide (CO) emissions from boilers and furnaces, Chloro-Fluro Carbon (CFC) emissions from refrigerants, etc. These toxic gases are produced in the chemical and fertilizer industries.

Cement plants and power plants are pumping out particulate matter. Modern inputs, outputs, and emissions of modern industrial processes as shown in figure 4.3.

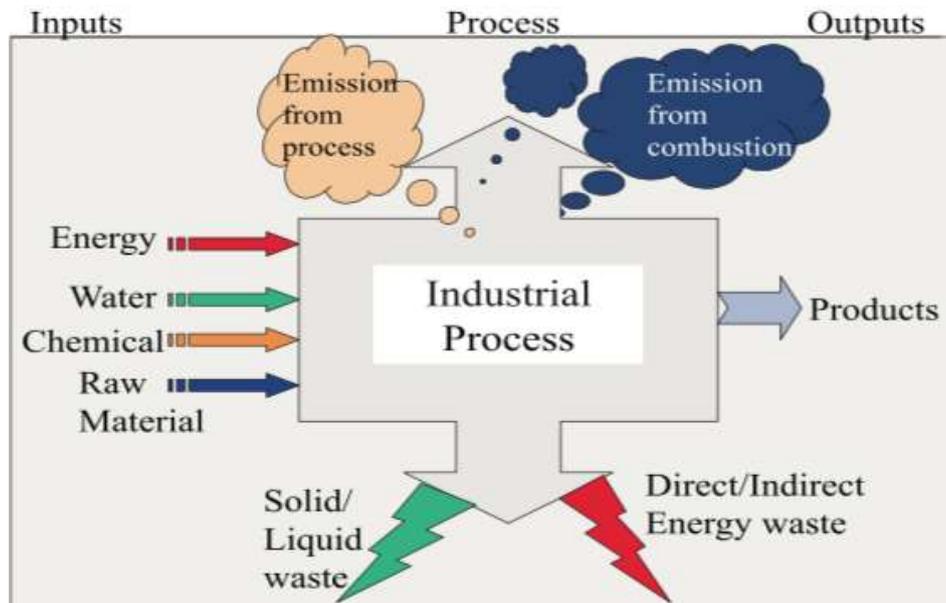


Figure 4-3 Input and output of industrial process³⁴

This has caused major pollution problems. A number of air contaminants have proven or suspected harmful effects on human health and the environment. In both developed and rapidly growing industrial countries, high levels of smoke and SO₂ resulting from the combustion of sulphur-containing fossil fuels, such as coal for domestic and industrial purposes, have typically been the main problem of historic air pollution. Air pollutants from these sources may not only create problems close to these sources but may also cause problems to distant areas. Air pollutants can travel miles, react chemically in the atmosphere to create secondary pollutants such as acid rain or ozone.

In both developed and developing countries, traffic pollution today poses a major threat to clean air. Petrol- and diesel-powered motor vehicles emit a wide variety of pollutants, primarily carbon monoxide (CO), nitrogen oxides (NO_x), volatile organic compounds (VOCs) and particulate matter, which have a growing effect on urban air quality. Industrial and domestic sources of pollutants together with their effect on air quality tend to be steady-state or improved over time. Nevertheless, the issues of traffic congestion are worsening worldwide. The problem may be particularly serious in developing countries with a dramatically increasing vehicle population, infrastructural limits, inadequate engine/emission control technologies and minimal maintenance or vehicle regulation.

The main pollutants produced by industrial, domestic and commercial sources are sulphur dioxide, nitrogen oxides, toxic organic micro-pollutants, particulate matter, ozone, carbon monoxide, hydrocarbons, benzene, 1,3-butadiene, lead, and heavy metals.

Climate Change

Human activities, in particular, the burning of fossil fuels, have made the blanket of greenhouse gases (water vapour, carbon dioxide, ammonia, ozone, etc.) thicker around the earth. The resulting increase in global temperatures is altering the complex web of systems that allow life to survive on earth, such as precipitation, wind patterns, ocean currents and distribution of plant and animal species. Cyclones, storms, hurricanes, floods and droughts are more frequent than before. This

³⁴Source: Bureau of Energy Efficiency

increase in extreme weather events cannot be explained away as some ordinary and random events. The trend towards more powerful storms and warmer, longer dry seasons is being forecasted by computer models. Warmer temperatures mean higher evaporation, and a hotter atmosphere can hold more moisture, so there is more high water that can fall as precipitation. Likewise, dry areas are likely to lose even more moisture if the climate is warmer, leading to more severe droughts and desertification.

Future Impacts of Climate Change

Even the minimum climate change forecast for the 21st century is likely to be significant and disruptive. Predictions of future climate change are wide-ranging. Global temperatures may rise from 1.4 to 5.8 degrees C; the sea level may rise from 9 to 88 cm. As a result, sea-level changes in this century are expected to range from small to catastrophic. This unevenness reflects the complexity, interdependence, and sensitivity of the natural systems that make up the climate.

Flooding and Storms

Extreme weather events, as predicted by computer models, are more frequent and may be expected to escalate and become more catastrophic. The possibility of more severe storms and flooding along the increasingly crowded coastlines of the world is possible. More frequent and severe downpours can threaten to degrade the quality of the source water. Additional storm water will exceed the design capacity of separate and combined storm water systems. In such cases, sewer systems may discharge untreated or partially treated storm water and sewage directly into nearby water bodies, resulting in threats to human health and water quality.

Loss of Biodiversity

Human health ultimately depends on ecosystem products and services (such as the availability of fresh water, food and fuel) that are required for good human health and productive livelihoods. Biodiversity loss can have a major direct impact on human health if ecosystem services are no longer sufficient to meet social needs. Most of the endangered species in the world (about 25 percent of mammals and 12 percent of birds) may be extinct over the next few decades as warmer conditions change forests, wetlands, and rangelands on which they rely and human development has prevented them from migrating elsewhere. Indirectly, changes in ecosystem services affect livelihoods, income, and local migration and, at times, may even cause political conflict.

Increases Diseases

Human activities are disturbing both the structure and functions of ecosystems and the alteration of native biodiversity. These disruptions decrease the abundance of some organisms, induce population growth in others, change the interactions between organisms and modify the interactions between organisms and their physical and chemical environments. Patterns of infectious diseases are sensitive to these disorders. Major processes affecting infectious disease reservoirs and transmission include deforestation, land-use change, water management, e.g. by dam construction, irrigation, uncontrolled urbanization, pesticide chemical resistance used to control certain disease vectors, climate variability and change, international travel and migration etc. Higher temperatures are expected to expand the range of some harmful "vector-borne" diseases, such as malaria, which kills 1 million people every year, most of them being children.

Shortage of Food

While regional and local effects can vary widely, in most tropical and subtropical regions, a general reduction in yields of potential crops is expected. Sub-Saharan Africa where dry land agriculture is rain-fed, the yields would decrease drastically even with minimum increase in temperature. Such changes could cause disruptions in the food supply chain in a world, which is already struggling with food shortages and famines.

Global Warming

Global warming is a long-term increase in the average temperature of the Earth's climate system. It is a major aspect of current climate change and has been demonstrated by direct temperature measurements and measurements of the various effects of warming. Global warming occurs when carbon dioxide (CO₂) and other air pollutants and greenhouse gases accumulate in the atmosphere and absorb sunlight and solar radiation from the surface of the earth. Ideally, this radiation will escape into space — but these pollutants which can last for years or decades in the atmosphere, trap the air and cause the earth to get hotter. This is what is known as the greenhouse effect. Other consequences of global warming include the melting of glaciers, sea-level rise leading to floods, severe droughts, heat waves, disruption of habitat, etc.

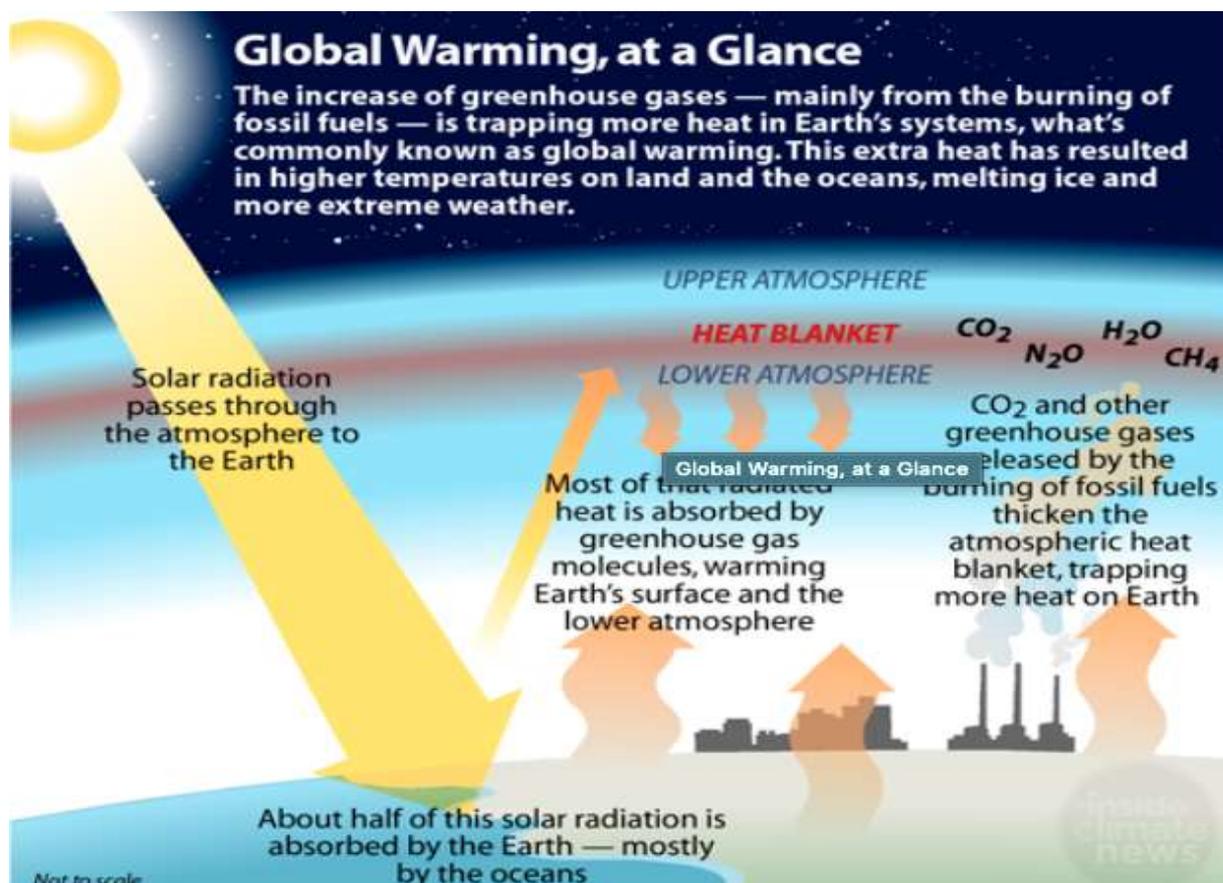


Figure 4-4 Global Warming at a Glance³⁵

Dwindling Freshwater supply

Salt-water intrusion from rising sea levels will reduce the quality and quantity of fresh water supply. This is a major concern, as billions of people on earth already lack access to freshwater.

Stressed World

Continuous environment harming exercises, for example, overgrazing, deforestation, and bared agrarian soils imply that nature will be more vulnerable than beforehand to climate change. So also, the world's immense human populace, much of it poor, is vulnerable against atmosphere stress. Millions live in hazardous places, for example, floodplains or in ghettos around the enormous urban

³⁵Source: NASA, Intergovernmental panel on climate change

communities of the creating scene. Often there is no place else for the populace to move. In the inaccessible past, man and his precursors relocated in response to changes in habitat. There will be considerably less space for migration in the future.

Global warming will almost definitely be unjust. The industrial countries of North America and Western Europe, as well as other countries such as Japan, are responsible for a large amount of past and current greenhouse gas emissions. Such emissions are due to the high standard of living enjoyed by people in these countries.

Yet those who suffer the most from climate change will be in the developing world. We have fewer resources to deal with hurricanes, floods, droughts, outbreaks of disease, and threats to food and water supplies. They are eager for economic development, themselves, but they may find that this already difficult process has become more difficult due to the change of climate. The poorer nations of the world have done almost nothing to cause global warming, yet are most exposed to its effects.

Acid Rain

Acid rain and acid deposition is a broad term that includes any form of precipitation with acidic components such as sulphuric or nitric acid falling in wet or dries form. These may involve rain, snow, fog, hail, or even acidic dust.

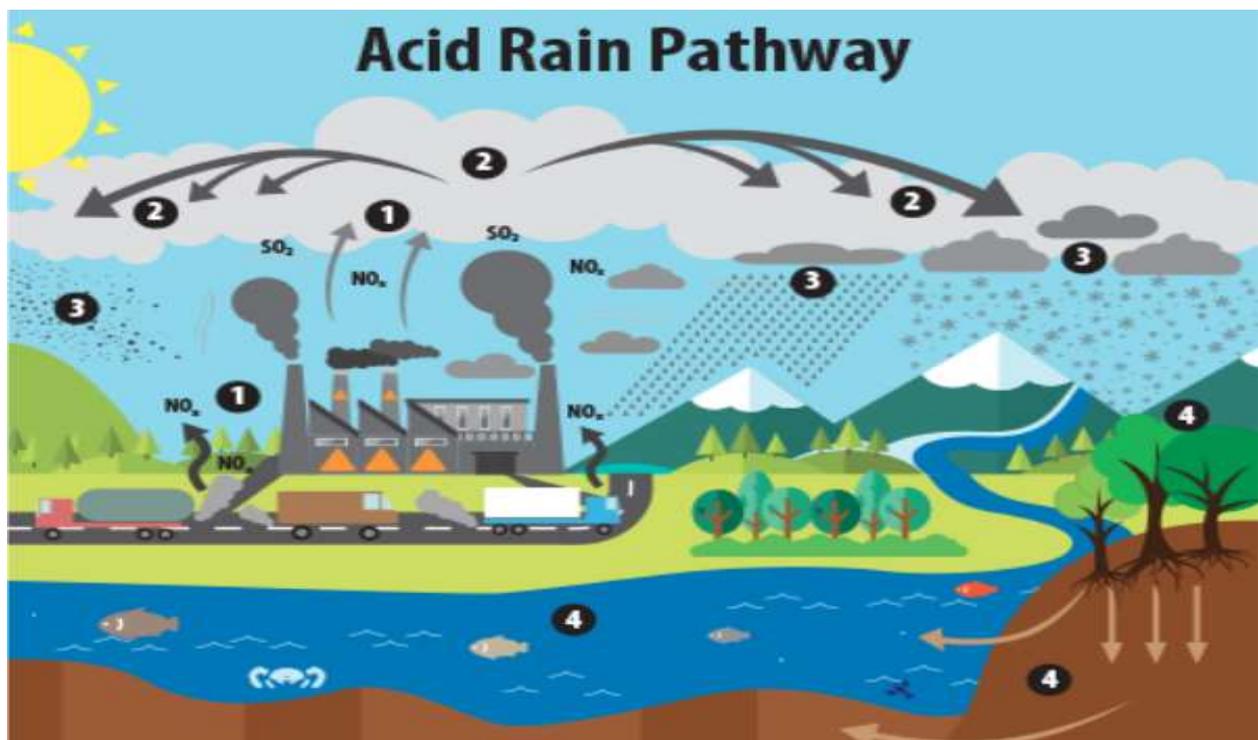


Figure 4-5 Acid Rain Pathway³⁶

The pathway for acid rain in our environment (1) Emissions of SO₂ and NO_x are released into the air, where (2) the pollutant is then transformed into acid particles that may be transported to long distance (3) These acid particles then fall to the earth as wet and dry deposition (dust, snow, rain etc.) and (4) may cause harmful effects on streams, lakes, forests and soil.

The harmful effects of acid rain include:

³⁶Source: EPA, United Nation Environmental Protection Agency

1. Acidification of lakes, rivers, streams, and soils
2. Direct and indirect effects on plants (release of metals, example: aluminium which washes away plant nutrients)
3. The killing of wildlife and biodiversity (trees, crops, aquatic plants, and animals)
4. The decay of building materials and paints, statues, and sculptures
5. Health problems like (respiratory, burning- skin and eyes)

To Do Activity

- Group work – Prepare a report on the analysis of energy consumption of at least 5 countries and comment on their future path taken. Also, compare the practices adopted by these countries to mitigate the energy crisis that is taking over the globe in the recent times. Prepare a short 5-minute presentation of not more than 10 slides. Organize the class into groups of 5.
- Individual work – Identify the impact of global warming in India and steps taken by the government or international and national organizations to mitigate the effect of global warming. Prepare a report of maximum 500 words.

4.2 Need for Effective Energy Resource Management

Energy Management: An Overview

Energy has become an integral part of modern life today. It has become the blood that runs through our bodies on a regular basis. But unlike blood, it's not self-generating, and of course, it's not free. It has a monetary price, but more than it does at the expense of the environment. It is very difficult to think about living a life without energy. But, at the same time, however, the generation of energy requires natural resources that are depleting on daily basis. On the other hand, the use of energy is increasing exponentially. In a developing nation like India, about 49% of total commercial energy is consumed in industries and utilities like Compressed Air, Air Conditioning, Hot water, Steam generation, Electrical systems, fuel, water system consumes a substantial part of total energy in these industries.

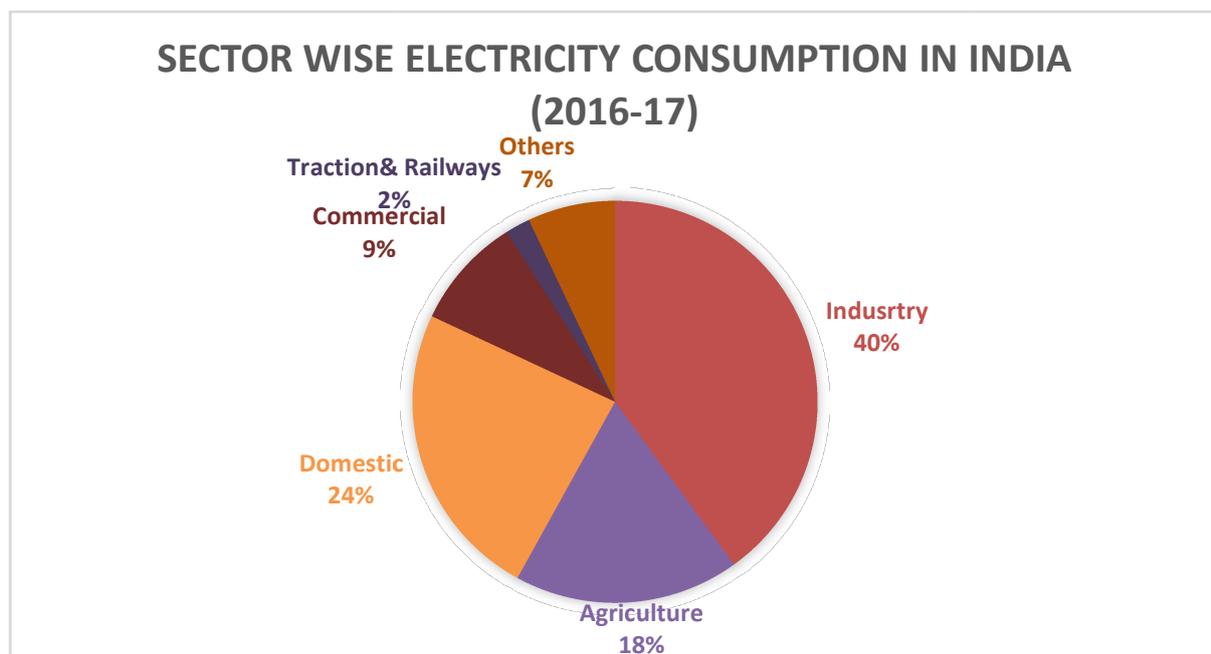


Figure 4-6 Sector wise Electricity Consumption in India (2016-2017)³⁷

³⁷Source: Central Statistics Office (mospi.nic.in)

The need to develop and sustain energy efficiency in industrial utilities is therefore strongly felt to survive and gain a competitive advantage in the current scenario of increasing energy costs and unpredictable energy markets. The application of energy-efficient technologies to improve energy efficiency (i.e. energy reductions per unit of output) in industries is often suggested as a means of reducing carbon emissions. In many situations where climate change is not an issue, energy efficiency changes can pay for themselves by reducing energy prices.

In India, energy consumption per capita is very small. As a developing country, it needs to achieve economic growth by growing the pace of development through industrialization. There are two ways of adjusting to the rate of industrial development. The first is to generate more and more industrial energy, which is difficult because of the depletion of natural resources, and the second is to reduce energy consumption by improving energy efficiency in industries, especially utilities. There should be a focus on reducing the energy consumption of industrial utilities through the usage of energy-efficient technologies. Also, focus on barriers to energy efficiency in industries and the training needs of the employees will lead to efficient energy management in industries. Industrial energy use in developing countries is estimated to represent about 45-50 percent of total commercial energy consumption. Much of this fuel is derived from imported oil, the cost of which has risen exponentially so much that many developing countries have invested more than 50% of their foreign exchange earnings.

In response to a wave of energy-related challenges, many companies around the world have reduced energy intensity by implementing and improving energy-efficient technologies and management strategies. This is a justification for their high energy end-use and high contribution to energy-related environmental issues. By doing so, companies have not only strengthened the protection of the environment but have also earned economic and social dividends. Numerous studies have highlighted the enormous gains made in the implementation of industrial energy efficiency and management measures. In particular, some of these studies have shown that greater savings can be made in developing countries.

Indian industry is using energy more intensively than is the practice in industrialized countries. Although selected modern Indian units often have a very high efficiency approaching the world's best practice standards, still the average strength lags at the world's best. The Indian industry has undergone a transformation since 1991 when the economy opened up to foreign investment and competition. Energy per unit of value-added in the industrial sector has since deteriorated. Nevertheless, there is still significant room for continuous improvement of energy efficiency in the Indian industry and for learning from both international and Indian best practices. (Sathare Jayant, Lynn Price, Stephane de la Rue du Can, David Fridley, 2005)

Considering the potential for energy savings, especially in manufacturing, the rapid depletion of energy resources and the harmful effects of energy consumption on the environment, it is highly required to understand the energy-efficient measures adopted by the industries and the barriers to their adoption. Thus, an investigation of barriers for the implementation of energy-efficient technologies in Industrial utilities is required to shed light on the rationale for the non-adoption of cost-effective industrial energy-efficient technologies.

India is one of the fastest-growing modern economies in the world today. With economic growth rates ranging from 8% to 9% in the last 6 years and a double-digit growth target for the next 10 years, the Indian economy has become a giant, quenching its thirst for energy. According to the Global Environmental Facility (GEF), the industry remains the largest energy user in the Indian economy, accounting for more than 50% of the country's total primary energy consumption. It is estimated that 13 million Micro, Small and Medium Enterprises (MSME) contribute about 45 percent

of manufacturing output and employ more than 40 million people. Most energy-intensive small and medium-sized enterprises rely on inefficient equipment, technology, and operating practices, leading to high energy consumption and significant CO₂ emissions. Indian industries are lagging behind in the use of energy-efficient technologies to improve energy efficiency due to a variety of reasons. Specific energy consumption in Indian industries is very high.

The main reasons for higher specific energy consumption in Indian industries include:

- Lower capacity utilization
- Raw material quality and poor handling
- Obsolete technology
- Improper metering and monitoring of energy consumption
- Substandard operating and maintenance practices
- Lack of knowledge and awareness among the employees
- Lower automation

The technical improvements, re-engineering, and continuous assessment, self-knowledge, and understanding among the masses are therefore a crucial step towards a system of energy conservation in any industry. There is a strong need to monitor energy use on a continuous basis and to relate it to specific energy consumption. Since a substantial share of energy resources is consumed in the generation, distribution and utilization of electrical and thermal utilities, improving energy efficiency in industrial utilities is the first step in energy management. It is therefore called "Energy Management in Industrial Utilities."

Energy Management: History

The "energy crisis" of 1973 acted as an eye-opener for all the petroleum importing nations around the globe. Due to the gulf war, the price of crude oil skyrocketed. This led to the recognition that energy sources may not be able to keep pace with the desire of mankind to use them. The supply of energy was no longer seen as something that was always ahead of demand. Instead, the supply of energy, although still vast, has now been seen as a behind the demand. This energy crisis led to a change in the world view of the usage of energy. It pushed the world to look for alternative ways of ensuring energy sufficiency. This need clearly indicated an increase in energy efficiency. The definition has shifted to "More output, more profitability and reduced cost of production." This promised an immediate, long-term and multi-faceted solution to the problems arising from increased energy demands against short supply. Since then, energy management has become the keyword for any profitable industrial unit. However, now the energy accounted for a substantial share of the cost of production in most of the industries.

Energy Management: Definition

Energy Management is "The judicious and effective use of energy to maximize profits (that is, minimize costs) and enhance competitive positions." Consequently, any management activity that affects the use of energy falls within this definition. The primary objective of energy management is to maximize profits and minimize costs by optimizing energy procurement and utilization throughout the organization, to minimize energy costs without affecting production and quality and to minimize environmental impacts. Among the practices arising from the description referred to above are the following:

Eliminate Waste: Ensuring that energy is used at the highest possible efficiency.

Maximize Efficiency: Utilizing the most appropriate technology to meet organizational needs.

Optimize Supply: Purchasing or supplying energy at the lowest possible cost.

Energy management practices may vary from simple maintenance and operational activities that ensure energy efficiency and efficient use of equipment and systems to capital intensive installation of new, more efficient technologies.

Some of the desirable sub-objectives of energy management programs include:

- Conserving energy, thus reducing costs
- Cultivating good energy communications
- Create and sustain active monitoring reporting and planning approaches for efficient energy usage
- Create and sustain active monitoring reporting and planning approaches for efficient energy usage
- Finding new and better ways to increase energy investment returns
- Developing interest in and commitment to the energy management program of all employees

Energy Management: Principle

The principle of energy management includes purchasing all the energy needed at the lowest possible price: e.g. purchase from the sources, review the terms of purchase, etc. Managing energy efficiently should be the next important task e.g. improving energy efficiency at all stages of energy transport, distribution and use. Once the energy is used the wastage should be reused and recycled with the use of most appropriate technology. Losses can be reduced by using waste generated within the plant as a source of energy, thus, reducing the element of purchased fuels and bills.

Energy Management: Benefits & Motivation

There are several driving factors for energy management in the industrial sector. They're:

- **Competitiveness**
While energy costs that represent a relatively small part of the total operating costs, for many industries, they are one of the most manageable assets between labour and product. Reducing energy consumption and thus reducing energy costs is important for any company to remain competitive.
- **Short Falls in power supply**
Due to the limitations of power supply infrastructures, most industries are faced with problems in terms of reliability and quality of power supply, and rising energy demand and industrialization have led to forecasts of a severe supply shortage.
- **Environmental Management Systems**
In some parts of the world, especially in Europe, the ISO 14001 environmental management standard is increasingly becoming a requirement for the trade. Energy management is an important component of environmental management and waste management policies and is a key feature in ISO14001.
- **Global Climate Change**
The global climate is changing due to human activity and one of the key causes of climate change is the release of Greenhouse Gasses (GHG), primarily CO₂, into the atmosphere from the burning of fossil fuels. Since fossil fuels are, directly or indirectly, an important source of energy for industry, there is an international pressure to reduce GHG emissions by reducing energy consumption.

Energy management can benefit both business and environment. Various business and environmental benefits include:

- **Reduced Cost:** Today’s energy costs are increasing dramatically; with the implementation of energy management systems in the organization reduce costs can be achieved, as you will only be charged for what you use.
- **Enhance Brand Reputation:** Running an energy-efficient operation and using renewable energy will improve relations with consumers, suppliers and other stakeholders, who may expect their suppliers to demonstrate their environmental responsibility.
- **Increased Competitiveness and Productivity:** Reduction in energy waste means you are doing more with less. Thus, reducing operating cost by reducing waste frees up capital to be used in other areas.
- **Improve Staff Wellbeing:** Evidence shows that people who work in energy-efficient environments are often more productive because workspaces are properly lit and not too hot or cold.
- **Reduced Carbon Footprint:** Energy efficiency is one of the most cost-effective ways to reduce the carbon footprint. Switching to renewable energy will help you reduce pollution even further.

Energy Management: Dimension

The industry which effectively controls its energy usage shows that technological solutions alone do not achieve maximum energy savings and are less likely to be maintained over the long term. Energy management has the greatest impact in resolving the following three dimensions, shown in Figure 4.7.

- **Organizational:** The structure and management systems that can support the achievement of energy efficiency objectives.
- **Technical:** Energy-consuming systems and devices which uses energy efficiently or inefficiently.
- **Human Behavioural:** Personal values, attitudes, and practices of individuals within the organization that have an impact on energy use.



Figure 4-7 Dimensions of energy management³⁸

Energy Management Cycle

There is a saying in energy resource management “What is not measured cannot be managed” Measurement and data management are now vital issues in Energy Management. The tools required for the job are now available to manage energy efficiently and cost-effectively. Energy management of any industrial establishment is purely based on the load estimates and planning of the distribution system. Energy Management is the stepping stone for the conservation of energy and processes involving cost reduction. The following Figure 4.8 shows the Energy Management Cycle.

³⁸Source: Department of Energy, South Africa (Industrial Energy Management)



Figure 4-8 Energy Management Cycle³⁹

Table 4.1 provides the various steps of energy management cycle and action required to achieve the goal.

Table 4.1 Energy Management Cycle explained⁴⁰

Energy Management Cycle Explained		
Step	Action	Where you might need help
1. Company Commitment	<ul style="list-style-type: none"> ✓ Sign up the Board and Senior Management ✓ Allocate resources – human and financial ✓ Write an Energy Policy 	<ul style="list-style-type: none"> - How to convince Board and senior management about the value that energy management will create - How to negotiate budget and human resource allocation – reasonability and expected return - How much time it will take? How many people hour required? - How to write energy policy that everyone understands and takes seriously?
2. Understanding Energy Use	<ul style="list-style-type: none"> ✓ Measure and evaluate the energy use and spend 	<ul style="list-style-type: none"> - Depending on the size and complexity of the business, clearly understanding your energy use can be a huge

³⁹Source: Energy Management Association of New Zealand

⁴⁰Source: Energy Management Association of New Zealand

		<p>undertaking. It needs to be thorough and accurate as it's the foundation of your plan.</p> <ul style="list-style-type: none"> - How does evaluation of the use of electricity, gas, transport fuel, and any other fuel/energy used, in all parts of the operation, and in all locations, is performed? - How to analyse historic data, trends for daily and seasonal cycles?
3.Planning and organization	<ul style="list-style-type: none"> ✓ Target areas for reduction and savings ✓ Get Staff involved ✓ Write and circulate the action plan 	<ul style="list-style-type: none"> - Once you know yours spend, how do you target areas for reductions and savings. What's possible? What's reasonable and achievable? - How to identify energy efficiency projects and write convincing business cases for the same? - How to get staff interested in contributing for ideas and staying involved? - How do you write an action plan that everyone understands and takes seriously?
4.Implementation	<ul style="list-style-type: none"> ✓ Launch your energy management programme 	<ul style="list-style-type: none"> - Have you set baselines for the use of energy by you? - Do you know the way to accurately measure all the benefits mentioned in your action plan? - Have you considered certification in energy management? - What internal or external reporting is required for your investments in energy upgrades?
5.Verification, Monitoring and Reporting	<ul style="list-style-type: none"> ✓ Measure and report the result ✓ Celebrate success with all members ✓ Keep looking for new ways to manage and save energy 	<ul style="list-style-type: none"> - How do you accurately measure and report results? - How can you build on your achievements and get even better results?

Energy Management Skills

Energy management requires a mixture of management and technical knowledge and skills. Management skills broadly entail bringing about awareness, motivating employees and workers, changing the structure and procedure to reduce wastage and increase efficiency, monitoring the consumption of energy, setting targets, norms, etc. This has to be done both at the organization and employee levels. Technical terms, on the other hand, include pre-requisite for improving the efficiency of the process or equipment such as boiler, furnace, assembly line, etc.

To Do Activity

- Group work – Organize the class into groups. Each group has to prepare a comprehensive report on any one of the renewable energy sources. Compare last 5 years' scope and expansion and management of the energy resource and comment on the viability of harnessing/investing in that resource for India. Presentation of progress through PowerPoint, not more than 10 slides.
- Individual work – Identify any India company and analyze the company's energy management activities. Also, recommend various changes the company can make to its energy management activities to attain better energy efficiency. Prepare a report of maximum 1000 words with appropriate diagrams. (Hint: Follow 'Energy Management Cycle Explained Table')

Energy efficiency is of the utmost importance to all organizations, particularly those that are energy-intensive. The four main criteria for effective energy management are technological capacity, monitoring system, action plan, and top management support. Any effective energy management system within an enterprise needs the full support of top management. Top management support is, therefore, a key requirement for performance. The management of energy should be seen as a continuous process. Strategies should be reviewed and revised annually as necessary.



Figure 4-9 the four pillars of successful energy management

Key activities of energy management include:

Identify a Strategic Corporate Approach

The initial point in energy management is to identify a strategic corporate approach to energy management. In this process need for clear accountability for energy management is to be established, followed by appropriate allocation of financial and staffing resources with reporting

procedures. This energy management program strategy requires commitment from the whole organization to be successful.

Appoint Energy Manager

The energy manager, a senior staff member in the organization, will be responsible for the overall coordination of the program with different stakeholders and will report directly to the top management. These energy managers need to have a technical background, need to be appropriately familiar with the organization's activities and have appropriate technical support.

Set Up System for Energy Monitoring and Reporting

Successful energy management includes the development of a framework for gathering data and reporting on energy costs and the use of the company. This will provide an overview of energy use and its associated costs, as well as promote the detection of savings that might otherwise not be identified. The system needs to record both historical and ongoing energy usage, as well as billing data cost information, and to be able to produce detailed reports on a regular basis. Such data will provide the means by which patterns can be evaluated and tariffs checked.

Conduct Energy Audit

The energy audit sets out both where and how energy is being used and the potential for energy savings. This involves a continuous questionnaire, a study of energy usage processes, an overview of energy use and the preparation of an energy budget, which provides a measure from which energy consumption can be measured over time. The audit may be carried out by an employee of an organization with appropriate expertise or by a specialized energy audit firm. The Energy Audit Report also provides proposals for action that will result in energy savings and cost savings. The costs and benefits for each proposed intervention and the order of priority for implementation should also be suggested.

Formalise an Energy Management Policy Statement

A written policy on energy management will direct efforts to improve energy efficiency and will show a commitment to energy savings. It will also help to ensure that the performance of the initiative does not rely on specific individuals within the organization. The Energy Management Policy Statement contains a statement of commitment from senior management, as well as general goals and clear objectives relating to:

- Reduction in energy consumption (electricity, fuel oil, gas, petrol, etc.)
- Reduction in cost of energy (by lowering consumption and negotiating lower unit rates)
- time tables
- Limits of the budget
- energy cost centres
- organization of management resources

Preparing and Undertaking a Detailed Project Implementation Plan

The implementation plan for the project should be developed as part of the energy audit and endorsed by the management. The plan should include the time-frame for implementation and any funding and budgetary requirements. Projects that range from setting up or modifying operating procedures to ensuring that plants and equipment use minimal power, re-negotiating electricity supply agreements, etc., to implementing asset acquisition programs that reduce energy consumption. The overall strategy would put in place energy management programs that would generate maximum financial benefits at the least cost to the company. Maintaining a high level of awareness among workers is a key factor in the success of the energy management program. This can be done in a number of ways, through formal training, newsletters, posters and magazines, and

by incorporating energy management into current training programs. It is important to communicate program plans and case studies showing savings and to report results at least at 12-month intervals.

Annual Review

The energy management program will be more effective if its results are reviewed annually. The analysis of energy management policies and strategies will form the basis for the design of an action plan for the next 12 months. The annual review must normally be conducted under the chairmanship of either the senior executive or, where possible, the CEO. As the policies are signed by the CEO, it is expected that the review will be carried out under his guidance in order to make implementation more effective.

Energy Management System

Organizations seeking financial returns from superior energy management are constantly striving to improve their energy performance. Their success is based on a daily review of energy quality, preparation, and execution of energy efficiency improvement action plans. A sound energy management system is, therefore, a requirement for the identification and execution of energy conservation steps, the preservation of momentum and continuous improvement. The various steps for energy action planning are shown in Figure 4.10.

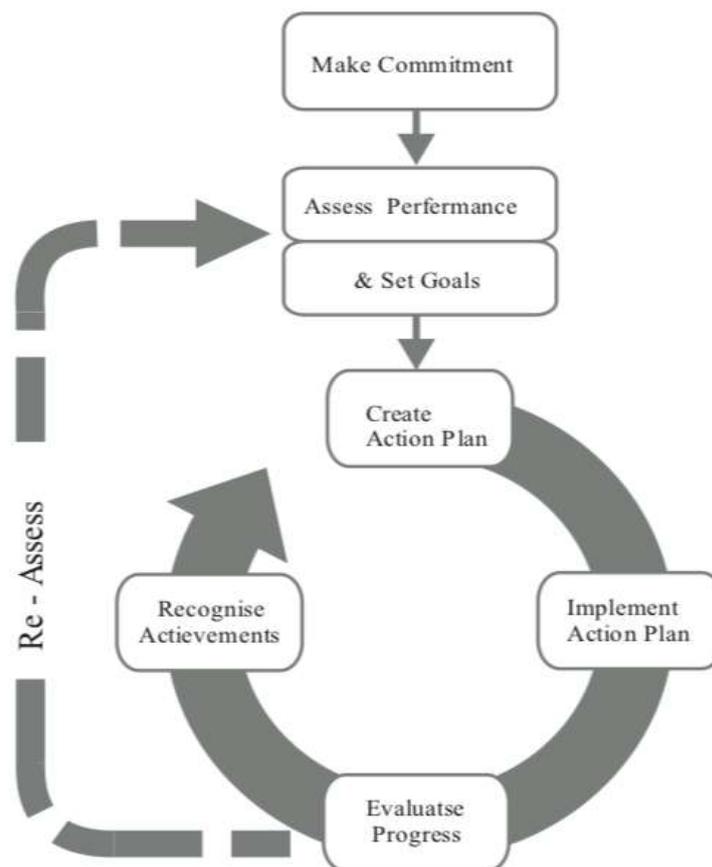


Figure 4-10 Steps in energy action planning⁴¹

Energy Strategy for the Future

The energy strategy for the future can be classified into short-term, medium-term and long-term strategies. The various components of these strategies include:

⁴¹Source: Sartwatt & Centrica Business Solutions

Short Term Strategy

- Rationalizing the tariff structure of different energy products.
- Optimal use of existing assets
- Promoting research and development, the transition and use of technologies and practices for environmentally sound energy systems, including modern and renewable energy sources.
- Efficiency in production systems and reduction of transmission losses, including those in traditional energy sources.

Medium Term Strategy

- Effective demand management through greater conservation of energy, optimum quantity fuel mix, structural changes in the economy, and an appropriate model mix in the transportation sector, i.e. greater dependence on rail compared to road for the movement of goods and passengers and a shift away from private to public modes for passenger transport; changes in design of varied products to reduce the material intensity of those products as well as recycling of used products, etc.
- There is an urgent need to shift to less energy-intensive modes of transport. This would include measures to improvise the transport infrastructure viz. roads, better design of vehicles, use of compressed natural gas (CNG) and synthetic fuel in vehicles, etc. Similarly, better urban planning strategies would also reduce the demand for energy use in the transport sector.
- There is a need to move away from non-renewable to renewable energy sources viz. solar, wind, biomass energy, etc.

Long Term Strategy

- Efficient generation of energy resources including efficient production of coal, oil and natural gas as well as reduction of natural gas flaring
- Improving energy infrastructure for building new refineries and creation of urban gas transmission and distribution network. Also, maximizing the efficiency of rail transport for coal production and building new coal and gas-fired power station.
- Enhancing energy efficiency for improving energy efficiency in accordance with national, socio-economic, and environmental priorities. Promotion of energy-efficiency and emission standards. Labelling program for products and adoption of energy efficient technologies in large industries.
- Deregulation and privatization of the energy sector, reducing cross subsidies on oil products and electricity tariffs and decontrolling of coal prices and making natural gas prices competitive. Also, privatization of oil, coal and power sectors for improving the efficiency of organizations.
- Proper regulated investment legislation to attract foreign investments. Streamlining quick approval process for attracting private sector participation in power generation, transmission and distribution.

4.4 Use of Alternative Energy

Renewable Energy Resources: An Alternative

The current use of renewable energy available from sunlight, wind, flowing water, wood materials, and waste include technologies, systems, and devices commercially available on the market. There is a need to change the attitude of adopting renewable energy devices in our daily lives, which will also ensure our contribution to the mitigation of greenhouse gas emissions and global warming. The Ministry of New and Renewable Energy (MNRE), GOI, has taken a number of new initiatives by launching a variety of schemes, such as a pilot project on tail-end grid-connected solar power plants, rooftop SPV systems and regional rating systems, and energy-efficient green buildings. A variety of technologies for renewable energy have become commercially available. These include biogas plants, solar water heaters, solar air heaters, solar heaters, solar lanterns, street lights, pumps,

improved wood stoves, wind generators, water pumping machines, biomass gasifiers, and small hydro-electric generators.

Energy technologies for the future, such as hydrogen, fuel cells, and bio fuels, are under active development. India is introducing one of the biggest renewable energy programs in the world. The country ranks second in the world in biogas consumption and fifth in the wind and photovoltaic production. Renewable sources now contribute about 5% of the country's total power generation capacity. Let us briefly describe the various forms of renewable energy.

Solar Energy

Solar energy is the energy received from the sun. India receives solar energy equivalent to more than 5000 trillion KWh / year, far more than the country's total energy consumption.

Hydel Energy

The energy generated from water is termed as Hydel Energy. This form of energy harnesses the power of water in motion for generation of electricity.

Biomass Energy

The fuel obtained from firewood and agro-residue is known as energy from biomass. The traditional chulha that is used in Indian villages is an inefficient way of using biomass energy. Ninety percent of the energy in the fuel is lost to the atmosphere and only ten percent of the energy is actually used to heat the pot for cooking purposes. Gasifiers convert wood, charcoal, and other biomass into a fuel gas that can be used to produce electricity. Approximately 1000 MW of power can be generated from urban and municipal solid waste and up to 700 MW from industrial waste in India.

Biogas Energy

The energy available from urban biodegradable waste and animal dung etc. is called biogas energy. Depending on the availability of the dung, biogas can meet the energy needs of nearly 40% of rural households in the country. There are approx. 232 million cattle in the country. While one-third of the dung generated annually from this is available for the production of biogas and recycled as farm manure, thus, 12 million family-sized biogas plants can be installed. Each plant could save about 1260 kg of fuel wood a year.

Wind Energy

The energy obtained from the wind is known as wind power. The Indian Wind Energy Program is one of the largest in the world, with an installed wind capacity of over 800 MW. India is ranked fifth in the world with a total wind capacity of 1080 MW, of which 1025 MW has been installed in commercial projects.

Geothermal Energy

The energy obtained from hot dry rocks, hot water springs, natural geysers, etc. is termed as geothermal energy. Below figure provides a source-wise estimated potential of renewable power in India

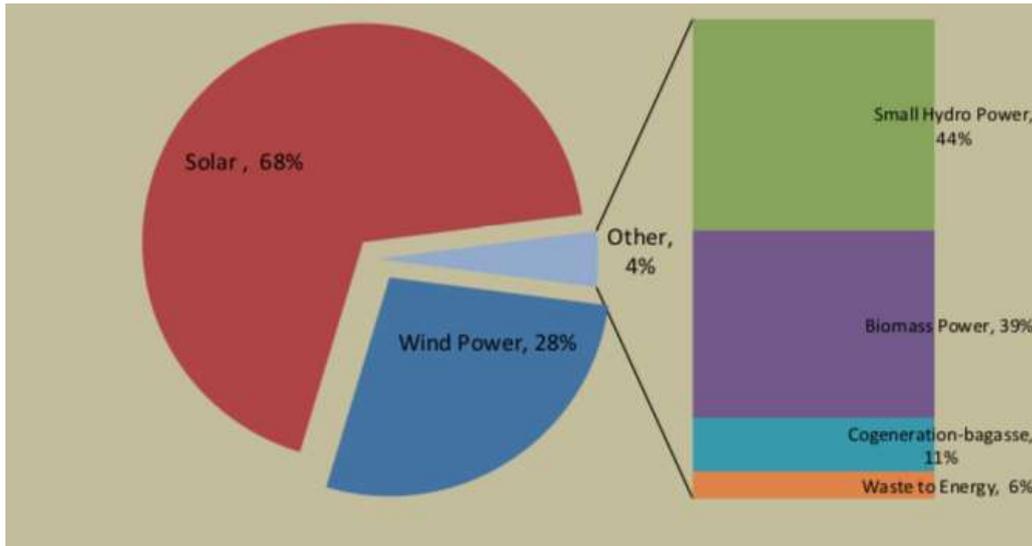


Figure 4-11 Source wise estimated potential of renewable power in India, 2018⁴²

Advantages and Disadvantages of Renewable Energy

Renewable or alternative energy sources are solar, wind, biomass, hydro, geothermal, ocean thermal, tidal, etc. All these renewable energies have several advantages as well as drawbacks. A description of the bird's eye is shown in Table. A brief look at the benefits of renewable energy is shown in Figure.

Table 4.2 Advantages and Disadvantages of Renewable Energy

Renewable Energy	Advantages	Disadvantages
Solar	Always available as long as sun is shining No pollution created	High initial cost Efficiency is low Lack of storage
Wind	Power available in windy, coastal areas No pollution created Available in abundance	Highly variable source Low efficiency (about 30%) Efficient energy storage needed
Hydro	High Efficiency No pollution Little waste heat Low cost to the user	May alter hydrological cycle Change watershed characteristics
Geothermal	High Efficiency Low initial costs	High local resource Non-renewable
Biomass	Biomass are natural Re-use is attractive Gives cogeneration facilities Practical for individual farmer	Pollution from biomass burners Transport is difficult because of moisture
Tidal	Steady source Capable of exploiting tides for maximum efficiency	Low duty cycle Huge modification in coastal environment High costs
Ocean Thermal	Enormous energy Steady flow Large scale use is possible	Highly technical Damage to coastal environment

⁴²Source: Energy Statistics 2019, mospi.gov.in

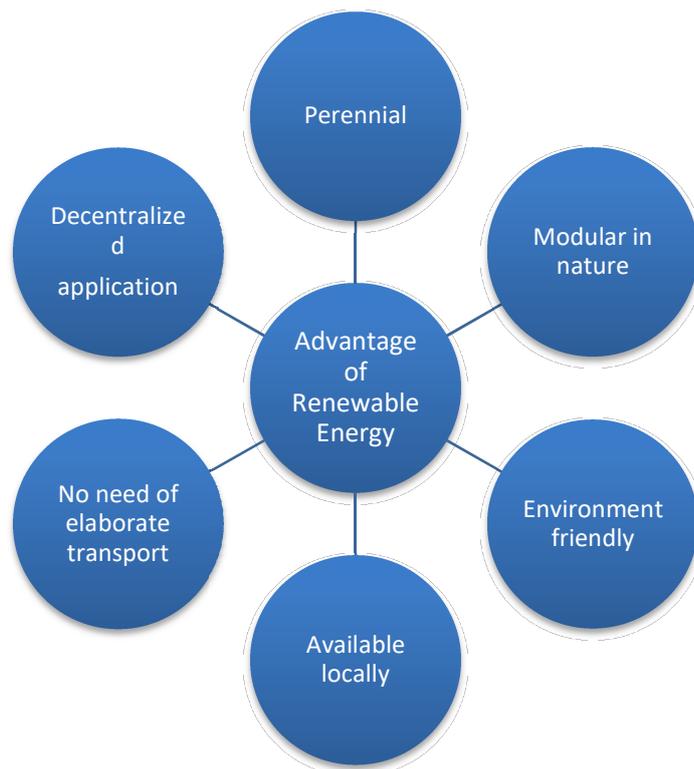


Figure 4-12 Pictorial representation of advantages of Renewable energy

We will now discuss about all the forms of renewable energy in detail:

Solar Energy

The Sun is located at a distance of 150 million kilometres from the Earth and is about a hundred times larger than the Earth. Most of the energy earth receives comes from the sun. Our sun and the other stars in the solar system are nuclear reactors that fuse various hydrogen atoms to form helium atoms. In this process, a huge amount of energy is released. The reaction is similar to what is happening in the hydrogen bomb explosion. In fact, all forms of energy that human beings have so far consumed and still consume are due in one way or another to the sun.

Solar energy, therefore, is the most readily available source of energy. It does not belong to anyone and is, therefore, free to use. It is also the most important and omnipresent non-conventional energy source because it is non-polluting and therefore helps to reduce the greenhouse effect. It is expected that soon millions of households around the world will be using solar energy. India is one of the few countries with long hours of sunshine. Solar energy could be harnessed quickly. In India, solar thermal energy is used for heating water for both industrial and domestic purposes.

Solar Energy Uses

India receives solar energy equivalent to more than 5000 trillion kWh / year, far more than the country's total energy consumption. In principle, solar energy can also be used to meet all our energy needs, both thermal and electrical. Solar energy can broadly be classified into two categories in terms of its usage:

- Solar Active Applications, i.e. direct use of solar energy for the production of electricity
- Solar Passive Applications, i.e. indirect use of solar energy commonly referred to as solar thermal applications.

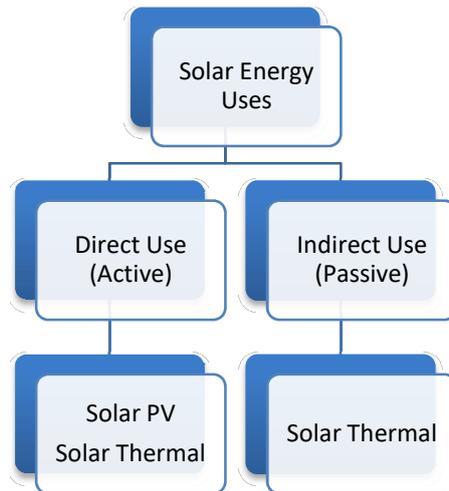


Figure 4-13 Uses of solar energy

The solar energy is directly converted into the desired application form. It is usually divided into the following two forms:

- (1) Solar thermal for heating applications and can be used as solar energy collectors etc.
- (2) Solar Photovoltaic for electricity generation can be used in street lighting, village electrification, water pumping, railway signals, etc.

Photovoltaic Cells

Only a handful of materials, particularly treated semiconductors, are known to have a PV effect with reasonable energy conversion efficiency. A vast majority of photovoltaic cells are made of silicon. These cells are classified either as crystalline (sliced from ingots or castings or cultivated ribbon) or thin-film (deposited in thin layers with a low-cost base). Also, these cells are the basic building block of the PV system. The cell may vary from about 1cm to about 10cm or more. However, only 1-2 watts are generated in one cell, which is not enough for most applications. So, to maximize power output, the cells are electrically connected into the sealed weather-tight module. These modules can further be connected to form an array. Array here signifies the entire power generating plant; it could be made of either one or a thousand modules.

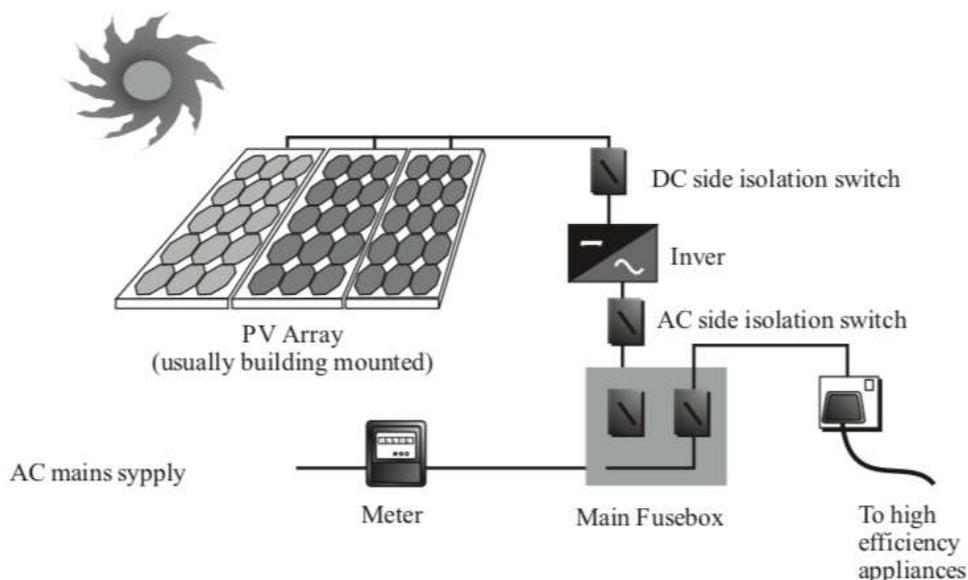


Figure 4-14 Application of photovoltaic cell⁴³

⁴³ Source : <https://www.sandiego.gov/development-services/permits/solar-photovoltaic-permit>

Biomass Energy

Biomass is a renewable energy source obtained when the sun's radiant energy is transformed into chemical energy by plants in a process called photosynthesis. It is the oldest form of energy used by humans and has been the main source of energy for human activity for thousands of years. Biomass is the most important energy source that helps the life cycles of humans and other animals. Wood, crops, and grass are all primary sources of bio-mass and secondary sources include wood, agricultural and food-producing waste as well as garbage. Bio-mass is used to generate electricity, fuel vehicles and heat for temperature control and manufacturing purposes. One process of converting biomass into transportation fuel is by fermentation of grains and blending it with gasoline. The usage of biomass does not result in a significant net increase in carbon dioxide into the atmosphere.

Bagasse, dry pulp residue left after the sugar cane juice has been removed, is used as a fuel for the generation of steam which, in effect, is used to produce power and process steam (co-generation plant). In view of the lower cost of fuel (because it is by-product), it proves to be the most economical fuel for cogeneration.

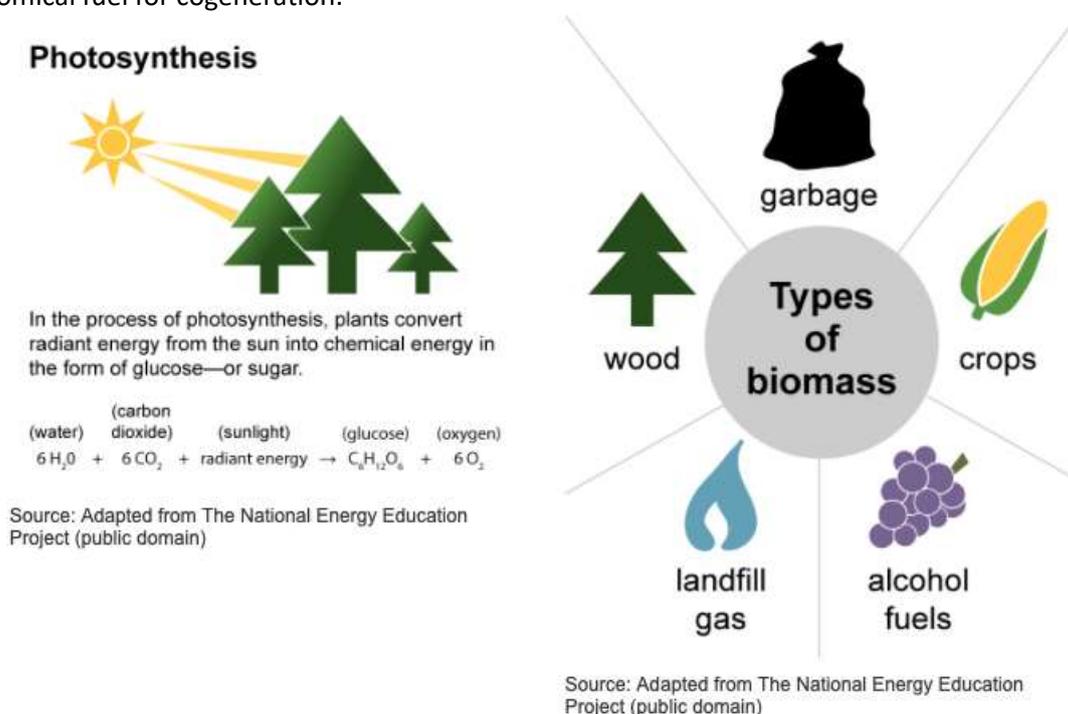


Figure 4-15 Type of biomass⁴⁴

Benefits of the Use of Alternative Energy

The environmental benefits of renewable energy, including lower carbon emissions and reduced air pollution, have been well known for decades. However, its numerous socio-economic benefits have only become apparent in recent decades as the deployment of renewable energy technologies has become more widespread.

Health

Solar, wind, and hydropower produce little or no air pollution. Other renewable energy-related technologies, such as biomass and geothermal, do emit air pollutants, but at much lower rates compared to most of the conventional fuels. Air pollution has become a critically important issue in

⁴⁴Source: U.S. Energy Information Administration (EIA)

almost all developing countries, wherein up to 2.9 billion people are still dependent on wood, coal, and charcoal for the primary source of cooking and heating homes. Cleaner options, including biomass and solar technologies, can play a vital role in this regard.

Resilience

Some renewable energy technologies are deployed in a distributed, modular manner, making them less prone to any large-scale failures. This brings advantages during severe weather conditions or complex emergencies, as such technologies can be rolled out quickly wherever needed, bringing electricity to people even at the remotest of the areas without any complex and time-consuming infrastructure development.

Access to Energy

Over one billion people lack access to electricity, while another one billion have unreliable supplies of the same. Enhanced efficiency, rapidly declining engineering costs and supportive policies have made stand-alone and mini-grid renewable energy technologies feasible for 80 percent of those without access in rural areas and small island developing countries to have access to electricity. One of the most compelling arguments for off-grid solutions is that they are decentralized, and because project development activities happen locally, job creation activities are also localized.

Employment

Renewable energy creates a significant and growing number of jobs worldwide each year. The renewable energy sector, according to IRENA's estimates, employed a record number of 10.3 million people worldwide in 2017, driven by rising investments. This, in turn, was also the result of rapidly falling costs, technological improvements and government policies to support renewable energy technologies and equipment.

4.5 Government Policies and Institutional Support

Government Policies

The government of India enacted the Energy Conservation Act, 2001 (52 of 2001) considering the vast benefits provided by energy-saving and efficient utilization of energy. The Act sets out a legal framework, an institutional arrangement and a regulatory mechanism at the central and state level for the implementation of energy efficiency in the country. Five major provisions of Energy Conservation Act include Designated Consumers; Standard, and Labelling of Appliances; Energy Conservation Building Codes; Creation of Institutional Set up (BEE- Bureau of Energy Efficiency) and Establishment of Energy Conservation Fund.

The Energy Conservation Act came into force on 1 March 2002 and the Bureau of Energy Efficiency (BEE) became operational on 1 March 2002. Institutional practices and programs on energy efficiency in India are now primarily guided by various voluntary and mandatory provisions of the Energy Conservation Act. The EC Act was revised in 2010 and the key changes to the Act are as follows:

The Energy Conservation (Amendment) Act, 2010

The Act empowers the state to define energy consumption requirements for equipment or appliances. The Government may also prohibit the manufacture, sale, purchase or import of notified equipment unless it complies with these standards. However, this prohibition can only be issued two years after the standards have been specified.

Major Amendments include:

- The Central Government may provide Certificate of energy saving to a particular designated consumer on adherence to energy consumption less than the prescribed standards and standards following the procedure as may be prescribed.

- The Central Government may, in consultation with the Bureau, determine the value of the energy consumed per metric ton of oil equivalent.
- The designated consumer whose energy consumption exceeds the prescribed standards and standards shall be entitled to purchase an Energy Savings Certificate to comply with the prescribed standards and standards.
- Commercial buildings with a linked load of 100 kW or a contract limit of 120 kVA and above fall within the competence of the ECBC under the EC Act.

Important features of Energy Conservation Act include:

- **Standard and Labelling**

Standards and Labelling (S&L) has been described as a key practice for enhancing energy efficiency. The S&L program, when in place, would ensure that only energy-efficient equipment and appliances would be made available to consumers.

The main provision of EC act included in Standards and Labelling are:

- Evolve minimum energy usage and performance standards for notified equipment and appliances
- Prohibit the manufacture, sale and import of such equipment which does not comply with the requirements.
- Introduce a mandatory labelling scheme for notified equipment to allow consumers to make informed choices
- Disseminate information on consumer benefits

- **Designated Consumer**

The main provisions of the EC Act on designated consumers include:

- The Government would inform energy-intensive industries and other establishments as designated consumers;
- Schedule to the Act sets out the list of approved consumers to which the energy-intensive industries, Railways, Port Trust, Transportation System, Power Stations, Transmission & Distribution Companies and Commercial Buildings or Establishments are concerned;
- Designated customer to have an energy audit carried out by a qualified energy auditor;
- Energy managers with specified credentials are expected to be appointed or appointed by the approved consumers;
- Designated consumers must comply with the energy consumption requirements and regulations laid-down by the central government.

- **Certificate of Energy managers and Accreditation of Energy Auditing Firms**

The main activities in this regard as envisaged in the Act are as follows:

A framework of professionally qualified energy managers and auditors with expertise in policy analysis, project management, financing and implementation of energy efficiency projects would be developed through the Certification and Accreditation Programme. BEE designs training modules and conducts a national level certification examination for energy managers and energy auditors.

- **Energy Conservation Building Codes**

The main provisions of the EC Act on Energy Conservation Building Codes are as follows:

- The BEE would prepare guidelines for the Energy Conservation Building Code (ECBC);
- These prepared guidelines will be notified to suit local climate conditions or other attention requiring factors by the respective states for erecting commercial buildings after the rules relating to energy conservation building codes have been notified. In continuation, these

buildings must have a 500-kW connected load or a contract specification of 600 kVA or above and are intended to be used for commercial purposes;

- Energy audits of specific designated commercial building consumers would also be prescribed.

- **Central Energy Conservation Fund**

The various EC Act provisions included are:

The Fund would be set up at the centre to establish a delivery mechanism for the large-scale implementation of energy efficiency programs, such as the acquisition of energy quality and the promotion of energy service companies. The Fund is expected to give a boost to R&D and demonstration in order to boost the market penetration of productive equipment and appliances. It would encourage the development of testing and development facilities and promote awareness of the consumer.

- **Bureau of Energy Efficiency (BEE)**

The Bureau of Energy Efficiency (BEE) is an agency of GOI, established under the Ministry of Power in March 2002 with the mandate to implement the Energy Conservation Act efficiently throughout the country. The Agency's function is to which will promote conservation and efficient usage of energy. The mission of BEE is to institutionalize energy efficiency programs, to facilitate delivery mechanisms in the country and to provide leadership to key players involved in the energy conservation movement. Its primary objective is to reduce the energy intensity of the economy. BEE is the first organization to promote energy efficiency, which has been given wide legal powers to enforce the provisions of the Act relating to energy conservation and also to take punitive action against defaulters.

The BEE will initially be funded by the Central Government through budget grants but will become self-sufficient over a period of 5-7 years. It would be allowed to collect an appropriate fee for the success of its assigned functions. In order to promote energy-efficient investment, Central Energy Conservation Fund and other funds raised from various sources are used by BEE for creative funding of energy efficiency projects.

- **Role of Bureau of Energy Efficiency**

The task of BEE would be to establish standards and labels for appliances and equipment, to draw up a list of approved customers, to define certification and accreditation procedures, to prepare building codes, to maintain the Central EC Fund and to conduct promotional activities in collaboration with central and state-level agencies. The role would include the growth of energy service companies (ESCOs), the transformation of the energy efficiency sector and awareness-raising through initiatives like clearinghouses.

- **Role of Central and State Governments**

The following role of the central and state governments is envisaged in the Act:

- Central-to notify the rules and regulations referred to in the various provisions of the Act, to grant initial financial assistance to BEE and the EC Fund, to coordinate with the various State Governments for notification, enforcement, penalties and adjudication.
- State-to update the Energy Conservation Building Codes in order to meet the regional and local climatic requirements, to create a state-level agency to administer, oversee and implement the provisions of the Act and to establish a State Energy Conservation Fund to encourage energy efficiency.

- **Enforcement through Self-Regulation**

The following self-regulation technique is recommended to be followed for the confirmation of areas requiring inspection of only two objects requiring inspection.

- Certification of energy consumption levels and production process requirements by the Accredited Energy Auditors is a means of ensuring that Designated Consumers have good energy efficiency.
- For energy quality and requirements, the stated values of the supplier would be tested in Accredited Laboratories by taking a sample from the market. Any manufacturer or consumer group may challenge the values of the other manufacturer and bring them to the attention of BEE. BEE may recognize as a measure of self-regulation the difficulty of testing in contested cases.

- **Penalties and Adjudication**

The main provisions of the EC Act on Penalties and Adjudication are as follows:

- Penalty for each offense under the Act would be in monetary terms, i.e. Rs.10,000/- for each offense and Rs.1,000/- for each day for continued non-compliance.
- The initial phase of five years would be the promotion and creation of infrastructure for the implementation of the Act. No sanctions would have been effective during this phase.
- The power to adjudicate has been conferred on the State Electricity Regulatory Commission, which appoints any one of its members to be an adjudicator for holding an enquiry in connection with the penalty imposed.

National Level Institutions

Various national institutions promoting energy conservation include:

- **The Energy and Research Institute (TERI)**

TERI was established in 1974 by Mr. Darbari S Seth. It is an autonomous, multi-dimensional entity, with a wide range of capabilities in research, policy, consultancy, and implementation capabilities in area of energy, environment, climate change, and sustainability space. It works with more than 1200 engineers, scientist, sociologist and economists to deliver insightful and high-quality research to enhance access to clean energy for all, developing green mobility solutions, enhancing forestry and biodiversity, addressing global climate change issues across many continents, enhancing forest conservation efforts among local communities, advancing solutions to rising urban transport and air pollution problems, and encouraging energy efficiency in the Indian industry. This carries out various training courses and publishes books as well.

- **Indian Renewable Energy Development Agency (IREDA)**

IREDA is a public limited government company established Non-Banking Financial Institutions in 1987 for promoting, developing and extending financial support for setting up projects related to renewable sources of energy like wind, hydro, solar, biomass, etc. IREDA financial assistance is available to companies for their energy-saving programs at a concessional interest rate of up to 70% to 75% of the overall project value over the long term.

- **Federation of Indian Chambers of Commerce and Industry (FICCI)**

It was established in 1927, the Federation of Indian Chambers of Commerce and Industry (FICCI) is a rallying centre for free enterprises in India. It promotes energy efficiency activities through energy audits, energy conservation seminars, training programs, and workshops. It has qualified experts in the field of energy audits and an experienced panel of training faculties. It is also an accredited energy auditor of the Petroleum Conservation Research Association (PCRA)

- **Petroleum Conservation Research Association**

In response to the oil crisis of the early 1970s, the government established the Petroleum Conservation Research Association (PCRA) in 1978 to identify and promote the measures to accelerate the process of conservation of petroleum products in various sectors of the economy. It was established under the ministry of petroleum & gas to work towards energy conservation with a special focus on energy-efficient industrial units. It provides financial support for research and development of fuel-efficient equipment and devices. It also organizes multi-media campaigns for building awareness for the conservation of petroleum products. Energy audits are also promoted and awards are given to State road transport companies, industrial units, energy auditors and ESCOs in recognition of their energy savings achievements by PCRA.

Table 4.3 Saving of petroleum products⁴⁵

Year	Savings (Crores Rs.)	Year	Savings (Crores Rs.)
1985-86	32	1993-94	417
1986-87	69	1994-95	491
1987-88	102	1995-96	570
1988-89	131	1996-97	675
1989-90	165	1997-98	863
1990-91	198	1998-99	1049
1991-92	261	1999-00	1425
1992-93	332	2000-01	1782

State Level Institutions

- **Madhya Pradesh Urja Vikas Nigam (MPUVN)**

Madhya Pradesh Urja Vikas Nigam Ltd. is a registered 'designated company' in Madhya Pradesh. MPUVN has conducted more than 450 energy audits in the manufacturing, residential, agricultural and commercial construction industries, saving Rs.35 crores per year. It has launched capacity building programs, convinced the government to make energy audits mandatory and set a target for energy savings of up to 30%.

- **Maharashtra Energy Development Agency (MEDA)**

Of all state-level organizations supporting energy conservation in the region, the Maharashtra Energy Development Agency (MEDA) is No. 1. The main energy management initiatives include energy savings, energy conservation honours, energy efficiency conferences and intensive training for BEE members. It maintains a list of energetic auditors and ESCOs. MEDA was designated as a nodal agency in Maharashtra under the EC Act.

- **Energy Conservation Mission (ECM)**

Having recognized the need to increase awareness of energy conservation measures in different sectors, the Institution of Engineers (India) has authorized the AP State Centre to establish the Energy Conservation Mission (ECM). The main objective of the ECM is to raise public awareness through the dissemination of information on energy conservation.

- **Energy Management Centre (EMC), Kerala**

EMC is an autonomous organization, established at Thiruvananthapuram (Trivandrum) in February 1996, under the department of power, Government of Kerala. EMC promotes

⁴⁵Source: PCRA data

conservation of energy in all the sectors of the economy through scientific and technological research, education and training as well as professional advice.

Chapter Summary

- Energy is classified into several types based on the following criteria: Primary and Secondary energy; Commercial and Non-commercial energy; and Renewable and Non-Renewable energy.
- Renewable energy resources are bio-mass and bagasse as bio-mass; wind energy, wind turbine capacity factor, power generation, hydro energy, solar energy, photovoltaic cells and PV system
- Indian energy scenario and long-term energy scenario are explained in brief. Energy supply like coal, oil, natural gas, electrical, nuclear power hydropower with sector-wise consumption of energy and the energy needs of a growing economy
- Energy and the environment go hand in hand. The energy conservation has a direct relation to degradation. The important features of the Energy Conservation Act highlight the need and importance to conserve energy for the future requirement.
- Energy is the ability to do work and work is the transfer of energy from one form to another.
- The objective of Energy Management is also to achieve and maintain optimum energy procurement and utilization, throughout the organization and to minimize energy costs/waste without affecting production & quality and to minimize environmental effects.
- Energy management should be seen as a continuous process. Strategies should be reviewed annually and revised as necessary.
- The four vital requirements for a successful energy management is
 - technical ability
 - monitoring system
 - strategy plan
 - top management support
- An energy Manager helps an organization achieve its goals by establishing energy performance as a core value.
- The government of India enacted the Energy Conservation Act, 2001 (52 of 2001) considering the vast benefits provided by energy-saving and efficient utilization of energy.
- Five major provisions of Energy Conservation Act relating to Designated Consumers, Standard, and Labelling of Appliances, Energy Conservation Building Codes, Creation of Institutional Set up (BEE- Bureau of Energy Efficiency) and Establishment of Energy Conservation Fund.
- National and State institutes on energy resource management.

Model Questions

- Define the following terms with examples?
 - (a) Primary and Secondary Energy
 - (b) Commercial and Non-commercial Energy
 - (c) Renewable and Non-renewable Energy
- How is pollution linked to energy consumption?
- What are the strategies required for management of energy in India?
 - (a) Short-term strategy
 - (b) Medium-term strategy
 - (c) Long-term strategy
- What are the implications of global warning?
- Describe the process of Acid Rain?
- What are the major pollutants in burning of fossil fuels?

- Name and explain five major provisions of EC Act?
- Why energy conservation is important in the prevailing energy scenario?
- Briefly explain about few state level institutes?
- What are the benefits of use of alternative energy?
- What are the advantages and disadvantages of different renewable energy sources?
- Why renewable energy sources are required?
- What are the various dimensions of energy management?
- What are the key activities in energy management?
- What is the motivation for good energy management?
- What is the impact of over-usage of energy on climate?
- Explain the role Bureau of Energy Efficiency (BEE)?
- Explain the role of government institutions for conservation of energy?
- Briefly explain about the various national and state level institutions promoting energy conservation?

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Chapter 5 Climate Change

Introduction

This chapter will provide a base for students studying Natural Resource Management. Knowledge of climate change will help people working climate change, development issues, including in businesses, government, development organisations, NGOs. How the climate is effected by the natural, human factors, how it will change over the next century, what will be its affect, mitigating steps should be known to the concerned persons. This chapter aims to give the idea of climate change and its evidence, mitigating steps by different responsible persons.

Objectives

- To introduce climate change
- To familiarise changes in the environment
- To explain climate change mitigation approach
- To familiarise the steps taken to combat climate change
- To explain how climate change will have an effect on rural livelihoods

Chapter Structure

5.1 Climate change: Introduction & Evidence

5.2 Changes in the environment

5.3 Climate Change mitigation approach

5.4 Steps taken to combat climate change

5.5 Climate Change effect on rural livelihoods

5.1 Climate Change: Introduction & Evidence

Climate is commonly thought of long-term average weather condition, generally averaged more than a period of 30 years. Climate of a location is affected by its altitude, longitude, latitude, terrain, water bodies. Climate system's indicator is temperature, atmospheric pressure, wind, precipitation, humidity by which weather conditions are measured. Over the time, increasing fossil fuel burning, land use change due to urbanisation & other factors are continuing to emit greenhouse gases- for example carbon dioxide (CO₂), methane (CH₄) and nitrogen dioxide (N₂O) into earth's atmosphere. Rise in these gases caused less amount of heat transferred back to space and increases the average global temperature and results into the change of climate. Characteristics of climate change are changes in precipitation amount, increase in global temperature, cloud cover, melting of ice-caps &

reduced snow cover, increase in ocean temperature & ocean acidity. Also, there are other threats like disasters including causalities, famines, forest fire, and biodiversity losses, etc.

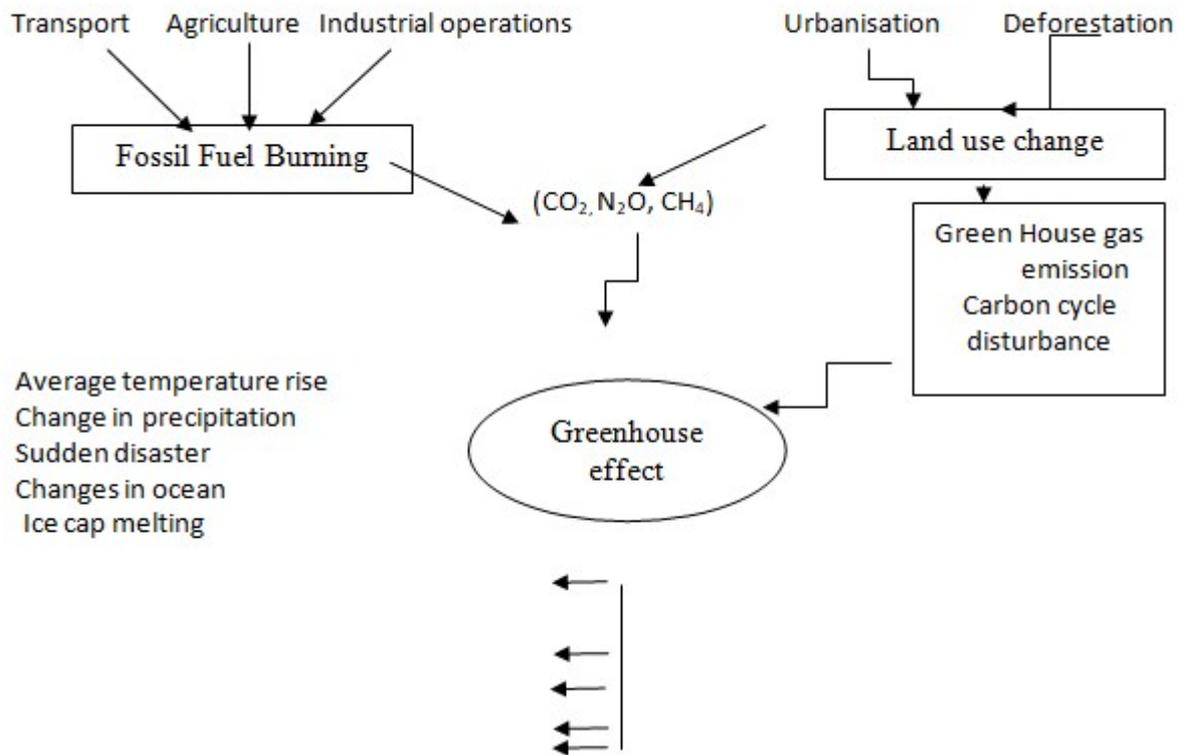


Figure. 5. 1 Climate change: Process & effect

Evidence of Climate Change

Climate change impacts and vulnerabilities varies by region and reported under various meeting, seminar under **UNFCCC (2006b, 2006c, 2007a, 2007b)**– United Nations Framework Convention on Climate Change- international treaty which is adopted on 9May, 1992. Climate change impacts across regions are not distributed equally. Floods, droughts in same area of Africa within month, disease outbreak in densely populated African region due to change in geographical distribution, for example migration of malaria mosquito to higher altitudes will expose to large number of unexposed people of the infection. Also, land & ecosystem of various regions are degraded, water & air quality are being deteriorating due to increase consumption and with associated waste. In Asia, more frequent natural disaster like Tsunami in 2004, Philippine landslide in 2006, Pakistan earthquake in 2005, unexpected & sudden heat waves, tropical cyclones, prolonged dry spell, thunderstorm, intense rainfall, snow avalanche, dust-storm are more frequent (Cruz et al. 2007). Effect of such disaster is loss of livelihoods, hunger, disease, human well-being, water resources, and biodiversity. Timing, amount of precipitation also affect the migration of fish species from the river to floodplains for spawning and growth (FAO 2003).

From the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2007), it is now clear that global warming is mostly due to man-made emissions. Over the last century, the average global temperature rose by 0.74° C which is evident from the following graph.

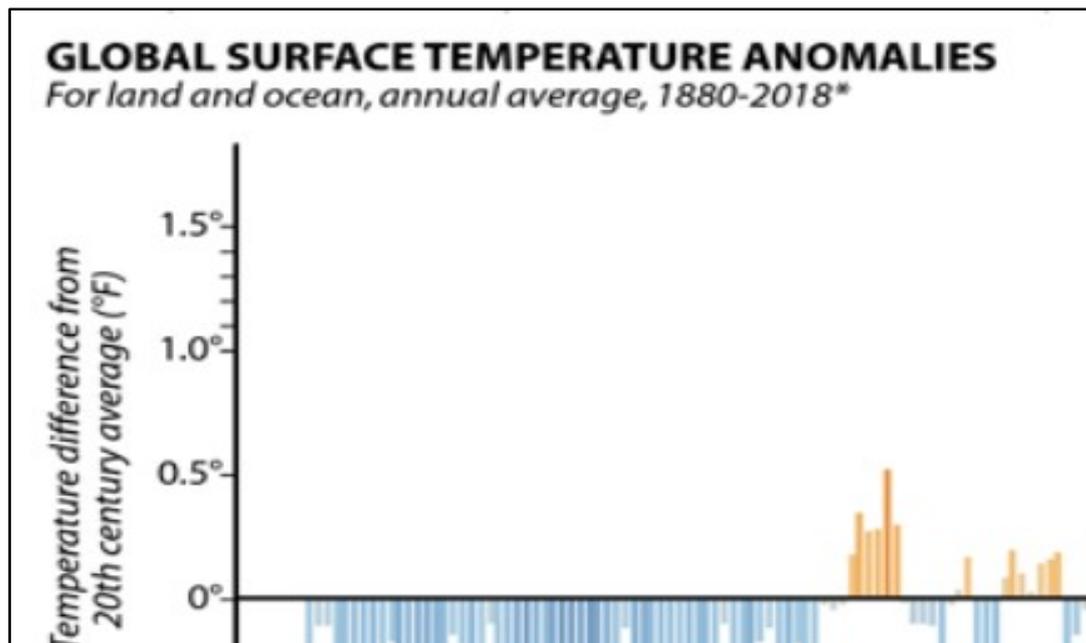


Figure 5.2 Global surface temperature (Source: US Global Change Research Program, NOAA, 2018)

In case of India, opposite phases of increase of minimum temperature in South India & decrease of minimum temperature in North India during summer, post-monsoon period have been noticed. In the last century, the atmospheric surface temperature in India has enhanced by about 1°C during winter and 1.1°C in post-monsoon months. Sea Surface temperature in Arabian Sea & Bay of Bengal also shows incensement. Also there is increase in number of severe cyclonic storms in Indian Cost (Dash, Jenamani & Kalsi, 2007, p.299). Observational evidence does not support any credible natural reason for this amount of climatic changes but points to human activity as dominant cause (Chaotic nature of natural variability of climate systems like El Nino & La Nina- periodic changes of Pacific Ocean sea surface temperature that affect the global weather across).

Satellite records show large-scale patterns of cloud change that are similar to those produced by model simulations of climate. Diminishing Arctic Ocean ice is also a concern. Climate change is expected to further disturb many areas of life, intensifying existing challenges to prosperity posed by stressed ecosystems, economic inequality. Cumulative changes documented by each of the climate indicators give a picture of warming world. Observed warming over the period of 1951-2010 was 0.65 °C and likely range of human activity to global temperature are 0.6 °C to 0.8°C during the same period (Knutson et al. 2017). Magnitudes of climate change related with medium- to high-emission poses an increased risk of abrupt regional change in the composition, structure function of water ecosystems. Future climate will depend on global warming caused by past anthropogenic emissions, as well as future anthropogenic emissions and natural climate variability.

Dangerous Climate Change

Dangerous climate change term was introduced in United Nations Framework convention on Climate Change (UNFCCC) which demands for stabilisation of greenhouse gases emission to the atmosphere to reduce the anthropogenic contribution towards climate change. Ecosystem can adapt to the changes in the climate naturally within certain timeframe if the anthropogenic impact is reduced. UNFCC leveraged this idea and in 10th Conference of Parties (COP) in 2004, European Climate Forum (ECF) symposium suggested three concepts of danger –

- i. Determinative dangers: Unprecedented consequences like extinction of global species, loss of ecosystems.
- ii. Early warning dangers: Already present but are likely to spread, worsen over time.
- iii. Regional dangers: Widespread over a large region like food security, water issues.

- iv. Details of the effect of climate change, loss of ecosystems cannot be efficiently predicted for example the loss of community composition of ocean ecosystem but wide range of plankton community has greater efficiency for processing carbons (Melillo_et_al_1990_IPCC1). Magnitude of climate change will vary according to the amount, timing of climate change. There are also different land use pattern across regions and land intensification increases the production of agricultural produce. This affects the cereal yield, nutrient use rate, body weight, number of draughts in dry land areas.

To Do Activity

Individual work - Prepare a list of climate change indicator. Based on these indicator, observe the weather change pattern in India, include abrupt changes from the normal course of weather, abnormal weather condition like storm, in recent five years. Also discuss the food security issues at rural areas that can be caused by the climate change effect. Prepare a report on the same.

5.2 Changes in the Environment due to Climate Change

Climate change affects all regions around the world. Polar ice shields are melting, sea is rising. In some regions extreme weather events like storm, changing patterns of rainfall, wildfires are becoming more prominent while in other regions are experiencing more extreme heat waves, droughts. Impacts have been expected to intensify in the coming decades. Another one impact is altered ecosystems as climatic patterns rapidly shift, habitats on land and in the sea are changing and also making it worse that some species left with no choice except extinction. The polar bear could disappear due to Arctic sea ice melt unless the pace of global warming slows.

Extinction of certain species when temperature rises to certain point, sudden storm surge in some parts of the world, sea level rising is abrupt change of environment. Arctic Sea level rising at three feet per century- projection by 2100 (Varmeer M, Rarmstorf S PNAS, 2009, 106:21527-21532)- 3 times faster than the records and 3 feet per 30 years would be far more alarming. Following figure shows two photographs from the same location in Alaska, depicting transition from tundra to wetlands over the last twenty years.



Figure 5.3 Example of change of land condition; Source: (Jorgenson, et. al., 2001, Climatic Change)

Also this type of slow environmental change is happening across the globe due to climate change affect. Food sources, human health issues under the current condition become a matter of concern. Growing season of crops is increasing in some parts since 1980. Also, The intensity, frequency, duration of North Atlantic hurricanes, other strong hurricanes have all increased since the early 1980s as per the records. Forest-fire like recent Australian Bushfire amplifies the climate change effect on environment.

Timeline

Climate change is long-term alteration of weather conditions. Century of research, data convinced majority of scientific community that human activity could alter the entire ecosystem. By late 1950, CO₂ reading provides some first data to substantiate the global warming with human produced CO₂. Many of the observed unprecedented changes are the atmosphere and ocean has warmed, the amounts of snow and ice have diminished, and sea level has risen. Carbon-dioxide emission is rising day-by-day and carbon content in the global atmosphere is piling up decade wise as evident from the following graph:

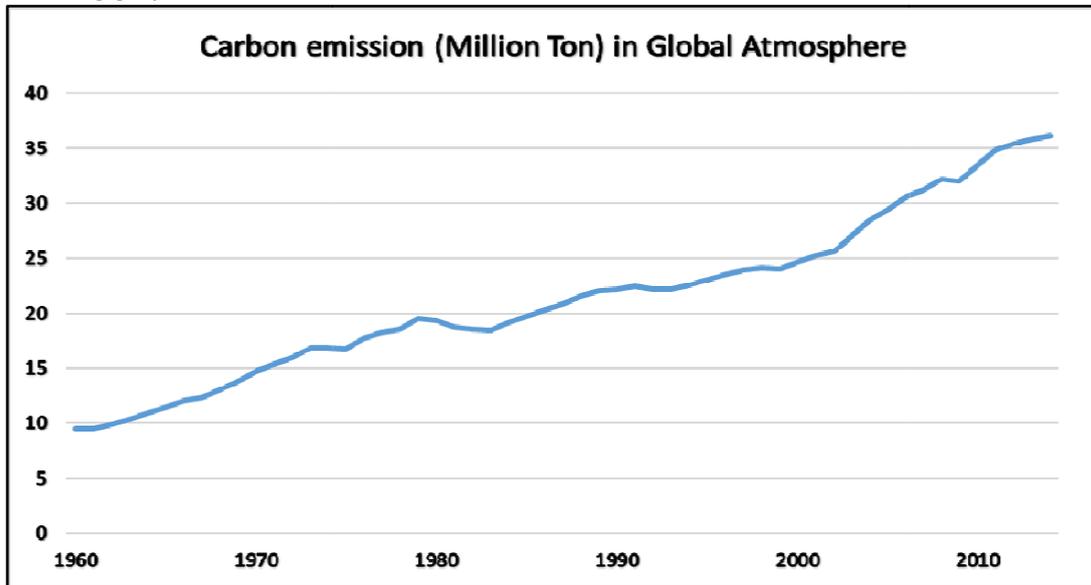


Figure 5.4 Carbon emission at Global Atmosphere, Source: World Bank data on climate change

In 1970, series of environmental study & research by US department of energy intensifies concerns about global warming and its affect. In 1979, first world climate conference adopts climate change as main issue and initiate actions to prevent anthropogenic causes of climate change. In 1985, first international conference in Austria on the greenhouse effect warned about the greenhouse gas and global mean temperature. As per records, 1980 was the hottest decade and 1987 was the hottest year till. Since the pre-industrial period, land surface air temperature increased nearly more than the global average temperature. Climate change, like increased frequency and intensity of extremes events, has badly impacted food security, terrestrial ecosystems and land degradation like desertification in many areas.

Also solar radiance variability has played role in the climate change. Greenhouse gases traps heat in lower atmosphere causing warming at the surface of earth and cooling in upper atmosphere. Following graph displays relation between surface temperature changes with the sun's energy that earth receives over the past decades.

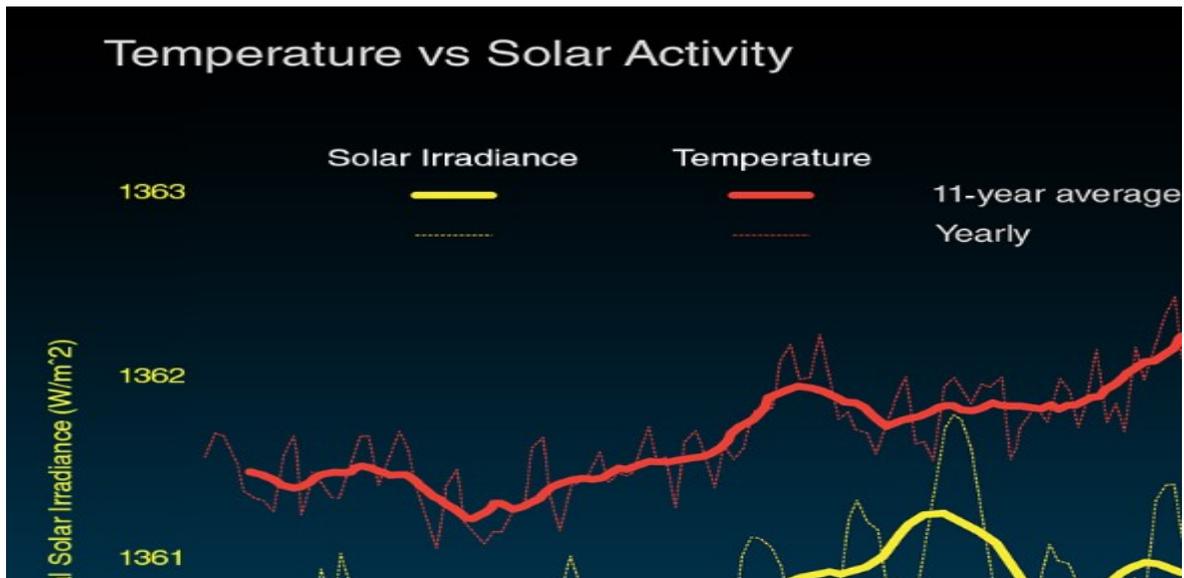


Figure 5.5 Temperature vs solar activity by earth's surface (Source: climate.nasa.gov)

United Nations sets up Intergovernmental Panel on Climate Change (IPCC) to analyse the impact, report, develop scientific assessment of climate change in 1988. IPCC stated that discernible human influence is present on climate change. Large Scale Ocean warming- El Niño in central pacific region – first recorded in 1986 which causes massive disruption of weather conditions like severe storm, flooding in large portion of globe for a longer period of time.

Kyoto Protocol defines emissions cuts for nations, adopts flexibility measures like allowing countries to meet their carbon emission targets partly by trading emissions permits, establishing carbon sinks such as forests. In 2012, Sustainable development goals were formed in United Nations conference on Sustainable development to counter the current global environmental challenges. Millennium Ecosystem Assessment report of 2005 highlighted irreversible bio-diversity loss of life of earth is contributed by human actions, climate changes with some 10-30% of the mammal, bird and amphibian species threatened with extinction in past decades.

In 2006, National Academy of sciences reported that global temperature has climbed which has not been seen in thousand years affecting the plant, animals. Paris agreement in 2016, signed by 197 countries are undertaken to improve, replace the Kyoto Protocol to better mitigate the greenhouse emission impact. Climate engineering- large scale intervention to remove carbon dioxide from atmosphere and giving solar energy back to the space- is an approach under taken in Paris Agreement to mitigate against the temperature increase predicted for the current century.

5.3 Climate Change Mitigation Approach

Climate change is directly linked with the change in indicator of global average temperature incensement. There is a direct relation present between increase in global average temperatures & more amounts of greenhouse gases in the atmosphere. So, the solution to the climate change problem rests in decreasing the amount of greenhouse gases emissions specially reducing the current concentration of carbon dioxide (CO₂). Mitigation for climate change aimed at avoiding, reducing, and delaying climate change mainly by reducing green house gas emissions into the atmosphere.

UNFCCC- United Nations Framework convention on climate change entered into 1994 with the objective to stabilise the greenhouse gas concentration in the global atmosphere, which requires all related parties to formulate, implement measures, program to mitigate the effect of climate change with aim to develop actions that will result in less amounts of GHGs. Measures include policies,

investment programmes, schemes which address all sectors which have potential of greenhouse gas emission- including energy, buildings, industry, transport, agriculture, forestry, and waste management. Mitigation measures to reduction of carbon concentration in environment are translated such as following figure:

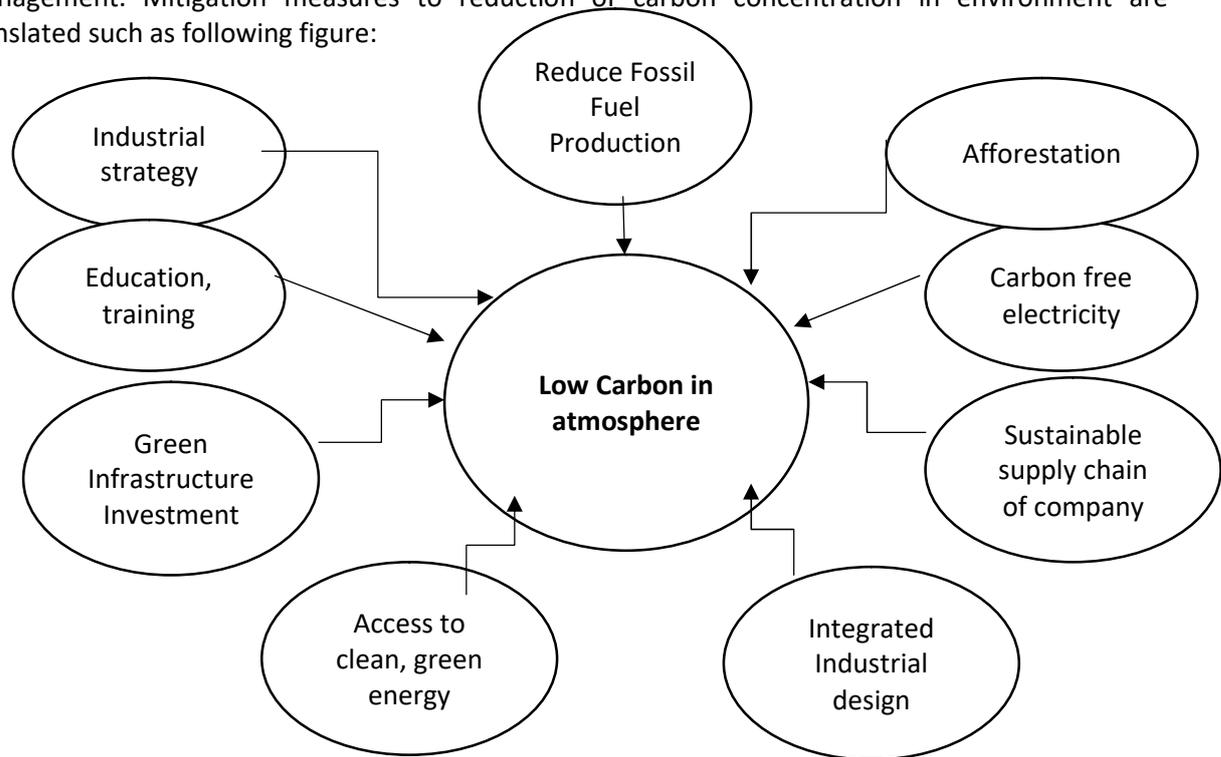


Figure 5.6 Climate change mitigation strategies

Some example of measures an increased use of renewable energy, application of new technologies such as electric cars, changes in practices or behaviours by consumers like change of preferences, also expanding forests and other sinks to remove more amounts of CO₂ from the atmosphere. Adaptation is those activity which is necessary for responding already unavoidable climate change because of past green house gas emissions.

Some of the mitigation measures of climate-resilient development pathways are:

- i. **Carbon Sequestration:** The process of storing carbon in a carbon pool. Following are the process of carbon sequestration.
 - a) **Afforestation-** Planting of new forests in those lands which historically did not have forests.
 - b) **Reforestation:** Planting of forests on lands which had been converted earlier from forest to some other use.
- ii. **Reducing Emissions from Deforestation and Forest Degradation (REDD):**Incentives for developing countries to reduce emissions from forested lands and invest in low-carbon paths to sustainable development (SD) through avoiding deforestation, degradations and includes the role of conservation, sustainable management, enhancement of forests & its carbon stocks to create more financial value.
- iii. **Carbon dioxide capture and storage (CCS):** A process by which stream of carbon dioxide (CO₂) from industrial, energy-related sources is separated (captured), conditioned, compressed and transported to a storage location for long-term isolation from the atmosphere.
- iv. **Carbon dioxide capture and utilisation (CCU):** A process in which CO₂ is captured and then used to produce a new product. CCU is sometimes referred to as carbon dioxide capture and use.
- v. **Carbon Geo-engineering/ Carbon dioxide removal (CDR):** Anthropogenic activities removing CO₂ from the atmosphere, storing it in geological reservoirs. It excludes the CO₂ uptake which is

not caused by human activity. This involves Carbon dioxide capture and storage (CCS) and Carbon dioxide capture and utilisation (CCU). This pathway includes afforestation, reforestation in the portfolio of management.

- vi. **Bio energy:** Energy derived from any form of biomass or its by-products. Pathways rely more on bio energy with carbon capture and storage (BECCS) along with afforestation.
- vii. **Green infrastructure:** The interconnected set of natural ecological systems, green spaces and other constructed landscape features which includes planted and indigenous trees, wetlands, parks, green open spaces and original grassland and woodlands. Green infrastructure provides services and functions in the same way as conventional infrastructure (Culwick and Bobbins, 2016).
- viii. **Behaviour change:** It can significantly reduce emissions, substantially limiting the reliance on CO₂ removal to limit warming to 1.5°C.
- ix. **Investments in green infrastructure:** Keeping warming below 1.5°C and enhance the capacity to adapt to climate risks would require large increases of investments in low-emission infrastructure, buildings along with a redirection of financial flows towards low-emission investments.
- x. **Ocean fertilization.** Adding iron to ocean would promote algae growth which means more underwater plants to consume the carbon. It is risky as it would affect other marine life also, carbon will sink to ocean floor if algae dies.
- xi. **Managing solar radiation.** Adding water droplets in atmosphere, adding solar reflectors in outer space increases cloud cover, reduces sunlight. This process has less evident to show any affect towards mitigating the climate change.

Adaptation to Climate Change

Adaptation is actions throughout society, groups, individuals and governments. Adaptation can be encouraged by several factors, like the protection of economic well-being. It can be displayed in numerous ways like market exchanges (Smit et al., 2000), through extension of social networks (Adger, 2003), through actions of individuals and organisations to meet their individual goals. Adaptation can be undertaken by individual for own benefit. It might also be made up of actions by governments to protect their citizens as well as have globally responsible.

Success of an adaptation strategy depends on how that action undertaken meets the objectives of adaptation and also ability of others to meet adaptation goals. Significantly, an action that is successful for one level like government, individual may not be classified as successful by another level.

Actions requires to build adaptive capacity may include building awareness of potential impacts of climate change, communicating climate change information to the society, sustain well-being, caring land usage, exploiting new opportunity along with maintaining economic growth. Adaptation effectiveness will depend on the reduction level of sensitivity thorough climate change. For example, new water reservoir provides future security of water supply and this security will depend on the degree of climate change, just like level of service provided by a flood protection dam will depend on the future flood events. Social & economic condition also has impact on the effectiveness of an action. For those individuals who take adaptation decision, action by themselves, many factors at individual level like declining incomes may reduce the effectiveness of measures. Attitude change towards regulation may impact the effectiveness of adaptation measures based on rules and regulations. Also, adaptation measure has some contradiction like it may be effective at reducing the impacts of climate change in certain locations or might increase opportunities; it may increase pressures on other side or impact on adaptation to climate change in other areas. For example- a flood embankment often simply increases flood hazard downstream.

Individual Approach Required for Mitigation Strategy

Individual and collective values could help surge in urgent, ambitious, cooperative change. Individuals can highlight their own action to drive the change which is required for cumulate damages made to the ecosystem. For example- sustainable choices like moving away from fossil fuel to renewable energy sources like solar, wind, geothermal, biomass will reduce the carbon footprint, sustainable consumption like reduction of consumption of energy by using of devices which consumes less electrical energy, use of public transport, moving towards sustainable infrastructure as consumer as Individual basis will reduce the global warming.

Also counter views is presence that climate change is planetary-scale threat and requires planetary-scale reforms to drive the required change. No doubt, individuals are not responsible for the climate change but to mitigate the climate change effect, individual's needs to change their approach, behaviour towards sustainable choices to protect the environment. Accepting 4R approach- reduce, recycle, recover, and reuse along with the change of consumer behaviour will make commitments for the change.

Eco-system constraints describes earth cannot support unlimited growth in consumption (Daly1996, 2005; Meadows et al. 1972; National Research Council 1999; Speth 2008). It is estimated that humanity's current cumulative consumption level already needs the resources of 1.4 earths, if whole world consumed at the level of consumption in the U.K., it might require 3.4 planets similar to earth and if the American level of consumption became the world norm, five planets would be needed (Bond 2005; Global Footprint Network 2009). Sustainable consumption like preferring eco-friendly product by individuals can neutralise the negative impact of consumption level. Eco-friendly product is generally produced by optimal usage of resources so that negative ecological footprint will be minimised.

There is need for self-realization, self-regulation among the people as consumers to conduct, behave in a manner that can help in at least minimizing the negative impact of consumption and production on the society & on the environment. Further companies must also create the way customer thinks by creating preferences for products, services consistent with sustainability. Lifestyles towards Sustainable Consumption and Production obtained after marked changes in cumulative consumer behaviour.



Figure 5.6 Cumulative individual affect to sustainability

Land Use Effect

Land makes available the basis for human livelihoods, well-being including the supply of food, freshwater, other ecosystem services. Land sinks greenhouse gases, plays role in the exchange process of energy, water and aerosols in between the land surface and atmosphere. Ongoing climate change including extreme weather events makes land ecosystems, biodiversity vulnerable. Justifiable land management can reduce the negative impacts of climate change on ecosystems and society. Agriculture, Forestry and Other Land Use (AFOLU) activities counts around 13% of Carbon

dioxide, 44% of methane, 81% of nitrous oxide emissions from human activities altogether during 2007-2016, representing 23% of total net anthropogenic emissions of Greenhouse gases. Following table represents the estimates of CO₂, methane (CH₄), nitrous oxide (N₂O) emission through ascertaining the data from FAOSTAT & USEPA-2012.

Gas	Units	Direct Anthropogenic				Total net anthropogenic emissions (AFOLU + non-AFOLU) by gas
		Net anthropogenic emissions due to Agriculture, Forestry, and Other Land Use (AFOLU)			Non-AFOLU anthropogenic GHG emissions ⁶	
Panel 1: Contribution of AFOLU						
		FOLU	Agriculture	Total		
		A	B	C = A + B	D	E = C + D
CO ₂ ²	GtCO ₂ yr ⁻¹	5.2 ± 2.6	No data ¹¹	5.2 ± 2.6	33.9 ± 1.8	39.1 ± 3.2
	MtCH ₄ yr ⁻¹	19.2 ± 5.8	142 ± 42	161 ± 43	201 ± 101	362 ± 109
CH ₄ ^{3,8}	GtCO ₂ eq yr ⁻¹	0.5 ± 0.2	4.0 ± 1.2	4.5 ± 1.2	5.6 ± 2.8	10.1 ± 3.1
	MtN ₂ O yr ⁻¹	0.3 ± 0.1	8.3 ± 2.5	8.7 ± 2.5	2.0 ± 1.0	10.6 ± 2.7
N ₂ O ^{3,8}	GtCO ₂ eq yr ⁻¹	0.09 ± 0.03	2.2 ± 0.7	2.3 ± 0.7	0.5 ± 0.3	2.8 ± 0.7
	Total (GHG)	5.8 ± 2.6	6.2 ± 1.4	12.0 ± 2.9	40.0 ± 3.4	52.0 ± 4.5
Panel 2: Contribution of global food system						
					Non-AFOLU ⁵ other	

Figure 5.7 Net Anthropogenic emission estimate in Tons (2007-2016)⁴⁶

There are two types of land use change due to human intervention- direct anthropogenic (and indirect changes. Anthropogenic changes include urbanisation, deforestation, reforestation, afforestation, agriculture. Indirect changes force change in vegetation due to change in carbon concentrations. Forestry has considerable potential to counter the effect of greenhouse gas emissions, helps to prevent significant climate change. Land use inclined to focus on trees planting, preserving forests, and changing cultivation practices to increase carbon storage in the soil. This type of practices makes it possible to increase carbon sinks.

To Do Activity

Individual work –Analyse whether proposals for mitigation seem equally achievable, realistic? Whether mitigation strategy is acceptable to the community and how it will be made realistic along with the economic growth of a nation? Use concept from the chapter and analyse according to your view point. Prepare a short report for the same.

5.4 Steps Taken to Combat Climate Change

United Nations Framework Convention on Climate Change (UNFCCC) is an international legally non-binding environmental treaty negotiated at the earth summit- United Nation Conference on Environment & Development (UNCED) in Rio de Janeiro in 1992 but entered into force in 21st March, 1994. Treaty provides a framework on limiting of greenhouse gas emission. UNFCCC had 195 parties under the framework convention. Several initiatives are discussed as below:

⁴⁶ Source: <https://www.ipcc.ch/srcccl/chapter/summary-for-policymakers/>

Montreal protocol, 1987: The Montreal Protocol is the first treaty to achieve universal ratification by all countries in the world. Through worldwide participation, the Montreal Protocol had sent clear signals to the global industrial market to repair the ozone layer, which was in peril. Montreal Protocol was signed to counter the deplete Ozone Layer and it has successfully reduced the global production, consumption, and emissions of ozone-depleting substances (ODSs) which are also greenhouse gases that contributes to climate change. Full implementation of the Montreal Protocol results in greater benefits worldwide by managing the emissions of substitute fluorocarbon gases, implementing alternative gases with lower global warming potentials.



Figure 5.8 Structure of IPCC (Source: <https://www.ipcc.ch/about/structure/>)

IPCC: In 1988, United Nations Environment Programme-UNEP and World Meteorological Organization-WMO jointly established the Intergovernmental Panel on Climate Change (IPCC) with purpose to assess the state of knowledge on the various aspects of climate change like science, environmental and socio-economic impacts and response strategies. IPCC’s assessments had a profound influence on the negotiators of UNFCCC. IPCC is organized into 4 bodies- three working groups and a task force on national greenhouse gas (GHG) inventories. Each of these four bodies has two co-chairmen (one from a developed and other from a developing country) and a technical support unit. Work of 3 different groups are - assesses the scientific aspects of the climate system and climate change, addresses the vulnerability of human and natural systems to changes in the climate and options for adapting to them, assesses options for limiting greenhouse gas emissions or mitigating changes as well as economic issues. Panel elects a bureau to provide guidance on scientific & technical aspects of its work. IPCC in recent assessment indicates that limiting global warming to 1.5°C compared to 2°C through rapid, far reaching unprecedented changes in all aspects of society could go hand in hand with ensuring a more sustainable and equitable society, environment.

Kyoto Protocol: It was adopted on 11 December 1997 but due to complex sanction process, it entered into force on 16 February 2005 with 192 Parties. Kyoto protocol operationalises UNFCCC though making commitment by industrialized countries to limit, reduce greenhouse gases (GHG) emissions according to the agreed individual countries’ targets, asks those countries to adopt policies, measures on mitigation and report periodically. Under the principle of “common but differentiated responsibility and respective capabilities”, protocol binds the developing nations as the protocol recognizes that they are largely responsible for the current higher levels of GHG emissions. Criticism of the Kyoto Protocol is introducing inequalities to determine the reduction of emission amount as protocol suggests countries to reduce their CO₂ emissions to below 1990 levels (B. McElroy, 2002, n.d.). Protocol gives credit for planting forests to sequester carbon, but in a way that provides economic incentives to destroy wetlands as associated releases of CO₂ is excess in case of wetlands from amount a forest might sequester (C. Wofsy, n.d.).

Conference of Parties (COP)-21: COP assesses the effects of the measures taken by Parties, progress made in achieving the ultimate objective of the United Nation Framework Convention on Climate Change (UNFCCC) through yearly conference. COP21 stands for the 21st time the countries are meeting to try to tackle climate change in Paris- which is generally called Paris Climate Agreement which brings all nations into a common cause to undertake actions to combat climate change adapt to its effects, assist developing countries in the process of implementing those. To make the Paris Agreement fully operational, work programme was launched in Paris to develop procedures, and guidelines on a broad array of issues. All Parties have to define their nationally determined contributions (NDCs) for greenhouse emissions and have to strengthen these efforts in the upcoming years along with reporting.

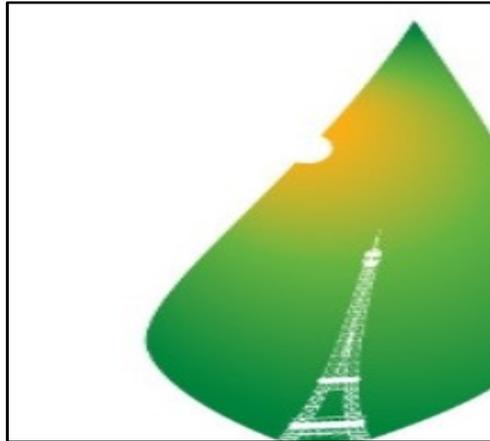


Figure 5.9 COP21 logo

Cancun Agreements: Cancun Agreements were adopted in 2010 United Nations Climate Change conferences. Its steps run in parallel with the Kyoto Protocol's second commitment period. Member countries determined 2020 emissions reduction targets or pledges in the form of nationally appropriate mitigation actions. For example- Australia and other few countries' pledge is to reduce emissions by five per cent below 2000 levels by 2020 and that is also have consistency with second Kyoto Protocol commitment.

Sendai framework: It is roadmap for Disaster Risk Reduction to make communities safer, more resilient to disasters. It outlines 7 clear targets, 4 priorities for action to prevent disaster risks. Four priorities are - strengthening the disaster risk governance, understanding the disaster risk, investing in the disaster reduction, enhancing disaster preparedness for effective response. This framework aims to achieve reduction of losses in lives, disaster risk, promote livelihoods, health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries over the next 15 years (2015-2030).

Millennium Development Goals: Millennium Summit of the United Nations in 2000 established eight international development goals for the year 2015 basically to address poverty on various aspects. Among those 8 goals, goal number 7 is "Ensure environmental sustainability" to address impacts of climate change like altered ecosystems, weather extremes, risks to society- a critical challenge for the society.

Sustainable Development Goals: SDGs replaced Millennium Development Goals (MDGs) - a global effort made in 2000 to tackle the indignity of poverty. Although MDG significant achievements have been made on many of the MDG targets, the impact was uneven across regions, countries and leaves significant gaps. Sustainable Development Goals (SDGs) were formed at the United Nations Conference on Sustainable Development held in Rio de Janeiro in 2012 with objective to produce

integrated, indivisible goals that meet the challenges and balance the three dimensions of sustainability- environmental, political and economic challenges.

Role of Government to Reverse Climate Change: Government can apply wide variety of policy tools to create incentives for mitigation action, for example regulation, taxation, tradable permit schemes, subsidies, and voluntary agreements. Impact of the Kyoto protocol's first commitment period (2008-2012) for global carbon emissions was expected to be limited, it had allowed the establishment of a global response to the climate problem, the creation of an international carbon market that may provide the foundation for future mitigation efforts.

Some of country's Government has created climate change plan with some measurable objectives which includes reducing emissions by 5 % below 2000 levels by 2020, by 2030 reducing emissions by 26 to 28 % below 2005 levels, doubling renewable energy capacity to be achieved in 2020. All those plans are driving technical innovation, creating jobs, create a pathway to provide a cleaner future. Encouraging the uptake of renewable things through the renewable Energy Target, improve energy productivity, protect green spaces, making policy environment to invest more in innovation, clean technology, and green infrastructure are some of the ways of governments to help mitigate the climate change.

Carbon Market: Under the Kyoto Protocol, parties (here countries) with commitments have accepted targets for limiting emissions. These targets of emissions are expressed as assigned amounts-a level of allowed emissions over the 2008-2012 commitment periods and measured by assigned amounts unit (AAU). Article 17 of the Kyoto Protocol sets Emissions trading which allows countries- that country which have emission units to spare or have emissions limits permitted to them but not used - to sell excess capacity to countries that are over their targets. Countries are talking about trading carbons as carbon dioxide is a critical greenhouse gas. Carbon is now tracked, traded like other commodity and this is known as the carbon market which aims to reduce emissions cost-effectively by setting limits on emissions, enabling the trading of emission units.

Initiative by Indian Government: Union Ministry of Environment, Forest and Climate Change, Indian government has taken actions under various sectors towards combating climate change. A number of new policies and initiatives are undertaken in different sectors which include e-mobility, green transportation, waste management, afforestation, renewable energy, water, etc. to minimise the impact of climate change. Some of the key initiatives of Government of India include the National Action Plan on Climate Change-NAPCC, National Adaptation Fund on Climate Change-NAFCC, Climate Change Action Programme-CCAP and State Action Plan on Climate Change-SAPCC. Also some ambitious goal to minimise the impact of climate change have been undertaken like generating 175 GW of renewable energy by 2022, smart cities, , energy efficiency initiatives, electric vehicles, changing norms from Bharat Stage -IV to Bharat Stage-VI emission norms for vehicles by April 2020 etc.

IMO & ICAO: International aviation accounts for around 1.3 per cent of global emissions and international shipping around 2.2 per cent- which represents a significant source of greenhouse gas emissions and are not directly addressed under the UNFCCC. International Civil Aviation Organization (ICAO) and International Maritime Organization (IMO) address the issues of emission by aviation, shipping by adopting different policy measures.

Role of Industries to Mitigate Climate Change: Companies with established organisation culture should have strong capabilities to change, a commitment for innovation to create significant value. Codifying new identity with leadership commitment, external engagement enables the process of readiness to change their behaviour towards balancing three dimensions of sustainability (ecological, economic, and social), to mitigate the negative impact of climate change or promoting the positive effect on environment. Then, significant is the building internal support for the new identity through employee engagement and mechanisms for execution- structured framework of practices & procedures to connect sustainability. Codifying new identity with building internal support for the new identity create a culture supportive of sustainability. Moving in the direction of sustainability, the company cultivates the foundation for a competitive advantage in the marketplace also which will benefit the company.

By adopting the mitigation initiatives mentioned earlier under climate resilient-development pathways like carbon capture through technical innovation, investing in green infrastructure (energy efficiency options) will reduce the business impact, help to adopt new climate conditions. Also there are some constraints from the side of the industry. For example- While a carbon tax or the price of a permit under a cap-and-trade scheme provide explicit prices. Non-price instruments like setting emission standards also place an implicit price on GHG emissions, as it requires automobile manufacturers to invest heavily in the technology to meet such standards and if the standards are tough, the cost will be very high.

Due to different reasons, there is dilemma about the harmony of the three pillars of sustainability. Leadership sometimes prefers environmental, social issues against financial returns. But to combat the climate change and to keep the environment conducive for future generation, company should reinforce the financial returns through sustainability. Company should form strategy like ingenious visionary where company need to focus on issues most relevant to their stakeholders and innovate majorly in product and processes- both. Company should work for pace setters as responsible business.

Additional readings: **

SDG has 17 goals (UNDP, 2015) as follows:

- i) End extreme poverty in all forms by 2030.
- ii) End hunger, achieve food security and improved nutrition and promote sustainable agriculture
- iii) Ensure healthy lives and promote well-being for all at all ages
- iv) Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
- v) Achieve gender equality and empower all women and girls
- vi) Ensure availability and sustainable management of water and sanitation for all
- vii) Ensure access to affordable, reliable, sustainable and modern energy for all
- viii) Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
- ix) Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
- x) Reduce inequality within and among countries
- xi) Make cities and human settlements inclusive, safe, resilient and sustainable
- xii) Ensure sustainable consumption and production patterns
- xiii) Take urgent action to combat climate change and its impacts
- xiv) Conserve and sustainably use the oceans, seas and marine resources for sustainable development
- xv) Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
- xvi) Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.
- xvii) Strengthen the means of implementation and revitalize the global partner.

To Do Activity

Group work - Write a comprehensive report about the various initiatives taken on Conference of Parties-Current situation of the initiatives taken by UNFCCC (Since COP1 to COP25). How the different parties (countries) are adopting those agreements, conference suggestion for their own national policy formation to reduce the climate change impact for future generations. Organise the class into seven groups based on the 7 continent and each group will be given each one continent to study, analyse the status of the UNFCCC initiatives. Presentation of the group will include the outcome of their findings. Prepare a very brief report for the same.

5.5 Climate Change Effect on Rural Livelihoods

Rural households, especially poor and marginal farmers, are facing greater vulnerabilities to their livelihoods. These vulnerabilities arise from a combination of social, ecological, market (economic), climatic/environmental and policy factors. Many studies also point out that natural resource dependent livelihood would further face a disproportionate burden of climate change and related shocks.

Some of the key challenges the rural livelihoods face emerge from

a. Degradation of Natural Resources: The challenge to rural livelihoods arises from environmental risks. The natural systems of a region – the forests, grazing lands, aquatic bodies, soil, nutrients, biodiversity etc. enable various production systems such as agriculture and livestock production which in turn determine the opportunities for livelihoods and incomes for the people of the region. Degradation of natural resources like land, water has led to adversarial economic, ecological consequences in contemporary rural society, where survival, sustenance are intimately linked to the productivity of the surrounding natural resources. Recurring droughts, injudicious removal of natural resources has further worsened the risks to farming dependent rural livelihoods.

b. Neglect of Common Pool Resources: One important component, albeit the most neglected one even in the schemes and programmes that purport to explicitly focus on physical resources, of the rural landscape is collectively used land and water resources. Even after years of degradation, encroachment, privatization and neglect by the state; forests, revenue land, grazing land, community ponds and water bodies continue to play an important role in rural people's lives. Local people depend significantly on these resources for fuel wood, fodder, timber, forage, food, medicines, drinking water for animals and other household requirements. Such dependence is higher in the case of poor, and grows more pronounced during the time of stress e.g. drought, crop failure etc.

c. Unclear Tenure Rights on Commons: It is implicit that one of the major causes of degradation of common resources like water, green forests, and pastures has been the removal of the rights of the local communities to use, manage their common resources; neglect of the customary local institutional settings on them. Over the last half century in the country, common lands are on the stage of decline by 31 to 35%. This decline can be attributed to the absence or weak tenure arrangements, acknowledging the customary rights of communities. Local communities have the knowledge, proximity, and rules to manage these natural resources effectively. Sometimes secure tenure right over common property rights engenders collective action ensures sustained commitment towards their conservation. Such tenure are also a major part of building democratic institutions for governance of natural resources.

d. Neglect of Community Institutions: Village level institutional structure is the foundation for effectively managing and governing natural resources, information gathering and dissemination, resource mobilization and allocation, skill development, capacity building, providing leadership, building network with other institution and decision makers. But this institutional structure is often the most neglected aspect in programs, policies. Given the critical dependence of marginalised communities- particularly poor and women- on natural resources for their subsistence need and also they have their general absence in decision making platform, there is a need to work with institutional arrangements with inclusion of all adult members under the institutional realm.

Strengthening Livelihood through Pasture Land Development

One example in this regard includes- Narsinghpura, a village located in Madhopur Panchayat in Begun tehsil of Chittorgarh district has population of around 660 inhabited primarily by the Dhakad, Rebari, Bheel, Vaishnav and Bairwa. Agriculture and animal husbandry are the primary source of livelihoods; however, many households are also dependent on local wage labor for their livelihood. The village has 360 bighas of pasture land or charagah which traditionally had open access and free grazing was the common practice. Due to this the plantations in the pasture were damaged and non-timber forest produce was negligible. The village institution with support of the project demarcated the pasture land and constructed a boundary wall around it through MGNREGA. The village institution also established rules to prevent the common land from being encroached, manage grazing practices, and put a ban on cutting trees. This has helped in regeneration. Sohini Bai, 60-year-old women from Bhil (tribal) community is engaged in collecting *ber* from pasture land for past many years. Earlier she used to earn around Rs.500-1000 by selling *ber*. But this time she made a profit Rs.20, 000 by just selling *ber* collected from the pasture land. She got prices as high as Rs.20/kg because not only the quantity but also quality of the *ber* has improved significantly.

“Sidhi si baath hai. Janwar ja ke sabh pedh kharab kar dethe hai, ab uspe rok lag gayi tho pedh paidhe ki sehat bhi achi ho gayi aur munafa bhi”

(Animals used to destroy all the plant in pasture land. Now that their entry is restricted, plant’s health is improved and so is the profit), remarked Sohini Bai.

Sustainable Livelihoods Approach:

Sustainable Livelihoods Approach which is termed as SLA widens the scope of analysis to all relevant features of people’s livelihoods. This includes a focus on the diverse strategies employed by the poor and how policy and institutional issues influence these strategies. It also looks at other factors beyond income that affect poverty, such as people’s education, nutritional status or access to natural resources.

An SLA is a more comprehensive way of organizing and analysing factors that influence poverty to help establish the objectives, scope and priorities for assistance. One of its main features is to shift the focus of development from outputs (such as the number of wells constructed) to people (access to water and how this matters to their livelihoods). Core concepts are people-centred, holistic, dynamic, build on strength, makes micro-macro linkages, and encourages partnerships, sustainability.

Recognizing the criticality of access to information, services and capital in strengthening livelihoods and resilience of rural households, key strategies designed for improving access to services, information and capital include (a) formation and strengthening of Self Help Groups to improve inclusion, participation, and access to capital, (b) promotion of sustainable agricultural practices such as seed treatment and seed replacement, line sowing, mixed cropping, application of non-chemical pesticides, horticulture, fodder and vegetable cultivation through a trained rural cadre, (c) supporting animal husbandry through breed improvement, organizing animal health camps to reduce mortality and improve livestock health, assisting livestock keepers in accessing government programmes and schemes for construction of cattle sheds and getting their livestock insured.

A number of frameworks (used to design intervention) have been proposed to help understand the complexity of livelihoods, illustrate the linkages between different factors that influence livelihoods, and identify where interventions can be made. Most frameworks show how three interacting elements (vulnerability context; livelihood assets; and policies, institutions and processes) lead to, and are affected by, diverse livelihood strategies and outcomes.

The vulnerability context: The activities people pursue and the assets that they invest in are fundamentally affected by external environmental factors (e.g. exposure to shocks) over which they have limited or no control. The vulnerability of a household is determined by its exposure to shocks and its ability to cope with or manage them.

- **Livelihood assets:** People draw on a range of assets to achieve positive livelihood outcomes. No single category of assets on its own suffices to yield all the varied livelihood outcomes that people seek.
 1. **Human assets:** the skills, knowledge, ability to labour and good health of people.
 2. **Social assets:** the social resources that people draw on in pursuit of their livelihood objectives, such as social networks or formal and informal groups.
 3. **Natural assets:** the natural resource stocks (e.g. land, forests, water) from which resources and services like erosion prevention, nutrient cycling which are useful for livelihoods are derived.
 4. **Physical assets:** the basic infrastructure and producer goods needed to support livelihoods, such as roads and railways, buildings (including shelter), water supply and sanitation and access to information (communication).
 5. **Financial assets:** the financial resources that people use to achieve their livelihood objectives, such as savings, money flows (cash or goods, from wage labour, remittances, etc.) and access to formal or informal credit.
- **Policies, institutions and processes:** The institutions, organizations, policies and legislation that determine access to the various assets, the terms of exchange between types of assets and the returns to any given livelihood strategy.
- **Livelihood strategies:** The range and combination of activities that people undertake to achieve their livelihood goals. People often combine three main livelihood strategies to meet their various needs at different times: natural resource based, non-natural resource based and migration to seek other sources of income. Understanding the variations in livelihood strategies that may exist across ethnic groups, households and individuals is important to tailoring interventions appropriately.
- **Livelihood outcomes:** The achievements (both improvements and deterioration) that indicate how successful households are in pursuing their livelihood strategies. This incorporates ideas of “sustainability” and the development of indicators to monitor or evaluate progress towards the elimination of poverty.

Possible Outcome

This will manifest in higher participation of men, women and youth in the village meetings, secure rights and access to resources, enhanced capacities of village institutions to resolve conflicts, to liaison and negotiate with Panchayats / external actors. Village institutions along with the cadre of community resource persons have also been playing a central role in improving access of individuals/households to programmes and schemes for financial inclusion, wage employment under MGNREGA, asset development (low cost housing, construction of cattle sheds, toilets), skill enhancement, pension and insurance schemes.

To Do Activity

Individual work - Prepare a list of programmes, policies that has been developed by the Indian Government to mitigate the climate change effect on rural livelihoods. Also asses the current status of those policies, programmes along with impacts.

Chapter Summary

The chapter is spread across four units. The first unit talks about the climate, how it changes and what will be the repercussion of the climate change, the evidence of climate change. Second unit talks about the changes in the environment that been observed over the years, timeline through which weather condition like temperature rise are being affected. Climate change can be manmade or natural but the focus is made on the manmade impact on climate deterioration. Fourth one depicts the various steps taken to mitigate the climate change effect. Individual steps, government initiatives, industrial steps required to follow the different goals, protocol, agreement to mitigate the climate change effect with focusing on the sustainability concern.

To Do Activity

Group Work – Take a country of your choice. Explore different climate change pattern in last some decades through national climate assessment, role taken by the government, industries of the nation and the people of the county. What is the impact of these steps? Write a comprehensive report based on sustainability. Explore the work in prospect of sustainability initiative that will impact the mitigation effect of climate change based on three dimensions. Organise class into groups and do this exercise as a group work whereby each group would explore the same according to the

Questions for Discussion

1. Discuss the climate change affect in different countries.
2. How climate change is happening over the years?
3. What is the significance of IPCC?
4. How mitigation strategy will help rural region of India, specially the farmer?
5. What are different initiatives are taken by IPCC? How its initiatives are being achieved, realised?
6. What are the sustainability dimensions and how it could be balanced with the growing capitalism?
7. What are different indicators of climate change and how it will be monitored?
8. What are the causes of greenhouses emission?
9. What are climate resilient development pathways?
10. What is sustainability? How industry can promote sustainability?
11. How industry can change to adopt the mitigation strategies for climate change?
12. What is and will be the world's perception about the initiative under mitigation strategy and international development?

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Editors' Profile

Dr W G Prasanna Kumar

Dr. W G Prasanna Kumar, Chairman, Mahatma Gandhi National Council of Rural Education (MGNCRE) prides in calling himself a Public Servant working for Climate Change. His expertise in Disaster Management has him in the advisory panels of several state and national level departments. He is also an expert advisor for the government of Telangana in its Disaster Response Force endeavour. A master trainer for Civil Services candidates, he conducts intensive training programs periodically at the behest of nationally recognized training institutes. He is currently actively involved in promoting higher education curriculum addressing rural concerns in India. **"Villagers to be producers not just consumers"** is his conviction that drives him to work for rural challenges. He aspires for an adaptive disaster risk resilient and eco-responsible India. The Curriculum on MBA in Waste Management and Social Entrepreneurship, and BBA and MBA in Rural Management are his major academic achievements dedicated to India's rural concerns. This has culminated in several collaboration MOUs for introduction of MBA/BBA Rural Management in Higher Education Institutions across India.

Dr. Prasanna Kumar excels in taking a vision and making it a reality and a plan into action, driven by a strong motive to achieve. He has translated positive intentions into tangible results. Being clear on the vision, defining a pathway, setting of the track with a clear destination point and quickly taking corrective actions as and when needed – are his prime qualities that make him an Achiever.

Under Dr. W G Prasanna Kumar's leadership MGNCRE has done nationally recognized instrumental work in building rural resilience including rural community engagement and Nai Talim - Experiential Learning. He has guided and helped MGNCRE in making key decisions and implementing agenda in several areas including Nai Talim (Experiential Learning), Community Engagement, Rural Immersion Programmes, Swachhta Action Plan activities, Industry-Academia Meets and Exhibitions on Waste Management, Comprehensive Sanitation Management in villages by working with Higher Educational Institutions, making curricular interventions in Waste Management and Rural Management, compiling Text Books on Waste Management and Rural Management, UNICEF (WASH) activities and several other related impactful activities. MGNCRE has become an interface for Government of India for promoting academic activity focusing on the rural concerns, being an advisor and a curriculum development agency for the Government of India. The Council is also now an RCI for Unnat Bharat Abhiyan.

Another pathbreaking achievement has been the formation of **Cells** through online workshops for institutionalising the efforts of MGNCRE. Vocational Education-Nai Talim-Experiential Learning (VENTEL) discuss MGNCRE's interventions in HEIs and making Vocational Education as a Teaching Methodology; Workshops on Social Entrepreneurship, Swachhta and Rural Engagement related activities in Higher Education Institutions has paid dividends and the key roles of the HEIs is highly appreciated by the Ministry. Building continuity and sustainability is being done through Social Entrepreneurship, Swachhta & Rural Engagement Cells (SES REC). Institutional level Rural Entrepreneurship Development Cells (REDC) Workshops/ FPO/FPC-Business Schools Connect Cells (FBSC) are organized with the objectives of Functionality of RED Cell; Preparation and Implementation of Business Plan and grooming students to be Rural Entrepreneurs.

A man with many firsts to his credit, and an incredible record of accomplishments, Dr. W G Prasanna Kumar is currently guiding MGNCRE in building a resilient rural India.

Dr K N Rekha

Dr K N Rekha, is a PhD Graduate from IIT Madras. She has 14 years of experience in training and education Industry. She works at Mahatma Gandhi National Council of Rural Education (MGNCRE), Hyderabad as Senior Faculty. She is involved in curriculum development on Rural Management and Waste Management. Prior to this, she worked as a researcher at Indian School of Business, Hyderabad, a short stint at Centre for Organisation Development (COD), Hyderabad. She has co-authored a book on “Introduction to Mentoring”, written book chapters, peer reviewed research papers, book reviews, Case studies, and caselets in the area of HR/OB. She also presented papers in various national and international conferences. Her research areas include Mentoring, Leadership, Change Management, and Coaching. She was also invited as a guest speaker at prominent institutions like IIT Hyderabad.

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Abhinav Verma is a post graduate in rural management from the Institute of Rural management Anand, Gujarat. He has worked at organizations like Agrostar. Currently he is employed at a leading corporate firm as Category Manager.

Nikita Lalge

Nikita Lalge is a post graduate in rural management from the Institute of Rural management Anand, Gujarat. She has a cumulative work experience of 30 months at Wipro as associate consultant prior to her post-graduation. She has graduated from Shri GS Institute of Technology and Science in the field of Computer science engineering. While pursuing her post-graduation, she has held positions of intern at Ladakh Ecological Development and assisted the organization in preparation of village development plan. She has also worked as a summer intern at Kaleidofin Pvt Ltd for developing better communication system with customers and identifying challenges while setting up field operations. Currently she holds the position of Account Manager at Kaleidofin Pvt Ltd.

Arkopal Saha

Arkopal Saha is a post graduate under the Post Graduate Program in Rural Management of Institute of Rural Management Anand (IRMA) - a premier institution founded in the year of 1979 by Dr. Verghese Kurien to create a new, unique breed of rural managers. He is a Mechanical Engineer by Educational background and has a keen interest to work for the Development Sector. He also interned at Mahatma Gandhi National Council of Rural Education, MHRD, and Hyderabad where he was entrusted with the task of mapping rural management education pan India through Institutional Networking. Currently he is employed as Senior Manager, Better World Foundation, A Non Profit working in the domain of policy advocacy, livelihoods and social impact. He has been associated with Yuva Mitra for a considerable amount of time as Manager – Research & Evaluation and EA at Yuva Mitra – A Development Organization that has revolutionized the face of goatery based livelihoods.



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