2.1 INTRODUCTION

Resources are objects, materials, creatures, or any form of energy found in nature that can be used to perform any useful function. They are or may become of potential economic interest due to their inherent properties.

Reserves are that part of a resource which has been fully evaluated and is found commercially viable to work on the consideration of mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors.

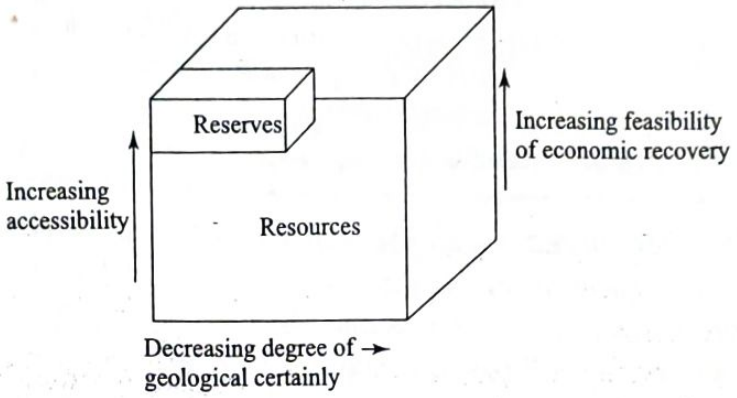

Fig. 2.1 *Reserves and resources*

2.2 TYPES OF NATURAL RESOURCES

Based on their use, availability, origin and economic status, natural resources can be classified into the following types:

2.2.1 Perpetual, Renewable and Nonrenewable Natural Resources

Based on their availability or how human activities affect them, natural resources are of the following three types:

(A) Perpetual Resources *Perpetual resources* are those natural resources that naturally perpetuate themselves and are not affected by human use.

Examples Sunlight, wind, rainfall water and tides.

(B) Renewable Resources *Renewable resources* are those natural resources that have the inherent ability to renew or replenish themselves if given a reasonable amount of time.

Examples Soil, fresh water, forest, etc.

(C) Nonrenewable (or Exhaustible) Resources *Nonrenewable resources* are those natural resources that cannot be regenerated or renewed or replaced within a time framework.

Examples Fossil fuels (such as coal, petroleum, natural gas, etc.), nuclear power.

Table 2.1 *Differences between perpetual, renewable and nonrenewable resources*

Perpetual Resources	*Renewable Resources*	*Nonrenewable Resources*
(i) They are replenished naturally at a rate faster than their rate of consumption.	(i) The environment has the capacity to replenish them as long as they are properly conserved.	(i) They are being consumed or used up faster than they can be made by nature.
(ii) They last forever regardless of anything humans do to them.	(ii) Human activities can affect the supplies of renewable resources.	(ii) Once these resources are used up, they are gone forever.
(iii) Examples: Wind, sunlight	(iii) Examples: Soil, forest	(iii) Examples: Coal, petroleum

(D) Intangible Resources

Intangible resources are those natural resources that are available in huge quantities, but at the same time can be destroyed easily.

The tourism industry is based on serenity, beauty, diversity, open space and satisfaction. However, a small piece of trash can easily destroy the beauty of any place. Thus, intangible resources are both exhaustible and inexhaustible.

2.2.2 Biotic and Abiotic Natural Resources

Based on their origin, natural resources are of the following two types:

(A) Biotic Resources

Biotic resources have originated from some living organism or have life.

Examples

- *Renewable*: Livestock, fisheries, flora, fauna and humans.
- *Nonrenewable*: Coal, petroleum, etc.

(B) Abiotic Resources

Abiotic resources are of nonliving origin.

Examples Minerals, rocks, water, etc.

2.3 FOREST RESOURCES

(A) Types of Forest Resources

Forests are broadly classified into there categories from the point of view of use as a resource:

(i) Old-Growth or Ancient Forests These are uncut forests that have not been seriously disturbed by natural disasters or human activities. As a result, they have attained great age, and thereby exhibit unique ecological features.

(ii) Second-Growth Forests They result from secondary ecological succession that takes place when forests are cleared and then left undisturbed for long periods of time.

(iii) Plantations These are (large, artificially established) forests of commercially valuable trees. These are created mostly by clearing old-growth or second-growth forests.

Table 2.2 *Differentiation characteristics of forests*

Forest-Resource Type	*Canopy Layer*	*Biodiversity*	*Prone to Disease*
(i) Old-growth	Several	More	Less
(ii) Second-growth	One	Less	More
(iii) Plantations	One	Least	Maximum

Example 1 *Automated analysis of forest satellite imagery is not reliable for estimating forest cover. Comment with respect to Indian perspective.*

Solution The Forest Survey of India (FSI) reported in 2009 that Indian forests had grown by almost 5% per year from the 1990s. They used automated analysis of forest satellite imagery.

The above method cannot differentiate between native forests and exotic tree plantations (such as rubber, teak, pine, eucalyptus trees). The plantation forest covers have very limited value for biodiversity.

Monoculture plantations are expanding by nearly 6,000 to 18,000 square kilometres per year in India.

If one subtracts plantations from total forest cover then India's native forests have actually declined at an alarming pace, from 0.8% to 3.5% per year from 2000–2005.

(B) Functions of a Forest Forests help in production of timber, regulation of stream flow, control of erosion, recreation, provision of wildlife habitat, etc.

2.3.1 Use and Over-exploitation of Forest Resources

Beneficial functions of forests are the following:

(i) ***Influence on Climate*** The crowns of the trees hold the moisture in because the force of the wind is broken. It makes the forest cool in the summer and warm in the winter.

(ii) ***Control of Run-off*** Leaves and branches of trees break the impact of rain, causing it to drip rather than have a strong force. Rain is absorbed by the ground, reducing surface run-off.

(iii) ***Flood Control*** Forested watersheds help in avoiding extremes of water flow and so help in flood prevention.

(iv) ***Wildlife Habitat Provision*** Wildlife uses the products of trees and forests as food and shelter respectively.

(v) ***Prevention of Soil Erosion*** Water moves slowly through forested soils and stays free of sediments.

(vi) ***Reduction of Wind Erosion*** Trees are used as windbreaks and slow down the force of wind.

(vii) ***Removal of Pollutants*** The roots of trees absorb soil and water pollutants. Sulphur dioxide is used for metabolism of trees. Thus, forests aid in the cleansing of air, water and soil.

(viii) ***Noise Abatement*** Trees act as a sound barrier.

(ix) ***Recycling of Nutrients*** Forests help in nutrient recycling.

(x) ***Provisions for Healthy Survival of Local Communities and Mankind*** Forests provide employment and income, aesthetic pleasure and spiritual solace. They also provide food, fibre, honey, medicinal plants and minerals.

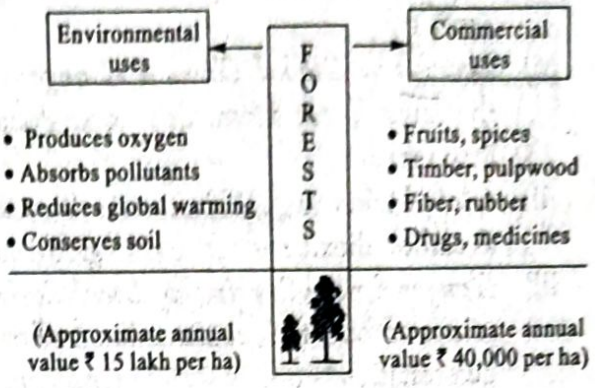

Fig. 2.2 *Environmental and commercial value of forests*

2.3.2 Deforestation

Deforestation involves the cutting down, burning, and damaging of forests.

Deforestation can be defined as the change of forest with depletion of tree crown cover of more than 90%. However, depletion of forest-tree-crown cover less than 90% is considered as *forest degradation.*

(A) Causes of Deforestation The main causes of deforestation are summarised below:

(i) Population explosion
(ii) *Agriculture*: shifting cultivation, overgrazing, cash-crop economy, etc.
(iii) *Commercial logging*: cutting trees for sale as timber or pulp
(iv) Poverty
(v) Mining
(vi) Dams
(vii) Infrastructure creation for logging
(viii) Forest fires
(ix) Acid rain
(x) Development projects and housing projects.

(B) Ill Effects of Deforestation The ill effects of deforestation are summarised below:

(i) ***Soil Erosion*** Soil is exposed to wind, sunlight, evaporation due to deforestation. Soil fertility goes down due to soil erosion and rapid leaching of essential mineral nutrients.

(ii) ***Harm to Fisheries*** As the soil is eroded, it accelerates siltation in dams, rivers, and the coastal zone. The increased sedimentation harms downstream fisheries.

(iii) ***More Floods and Droughts*** Because of deforestation, there is no regulation of the flow into rivers. As a result, floods and droughts alternate in the affected areas.

(iv) ***Habitat Loss of Wildlife*** Butterflies, migratory birds and wild animals suffer due to the loss of their habitat.

(v) ***Extinction of Some Species*** Many species are affected and some become extinct.

(vi) ***Local and Global Climate Changes*** The rainfall pattern is affected as the forest is cut down. Local and global climate changes may result from deforestation.

(vii) ***Global Warming*** If the trees are burned, the carbon is released immediately as carbon dioxide which lead to global warming.

(viii) ***Danger for the Survival of Local Communities*** Communities lose their source of food, fuel, construction materials and areas for livestock grazing by deforestation.

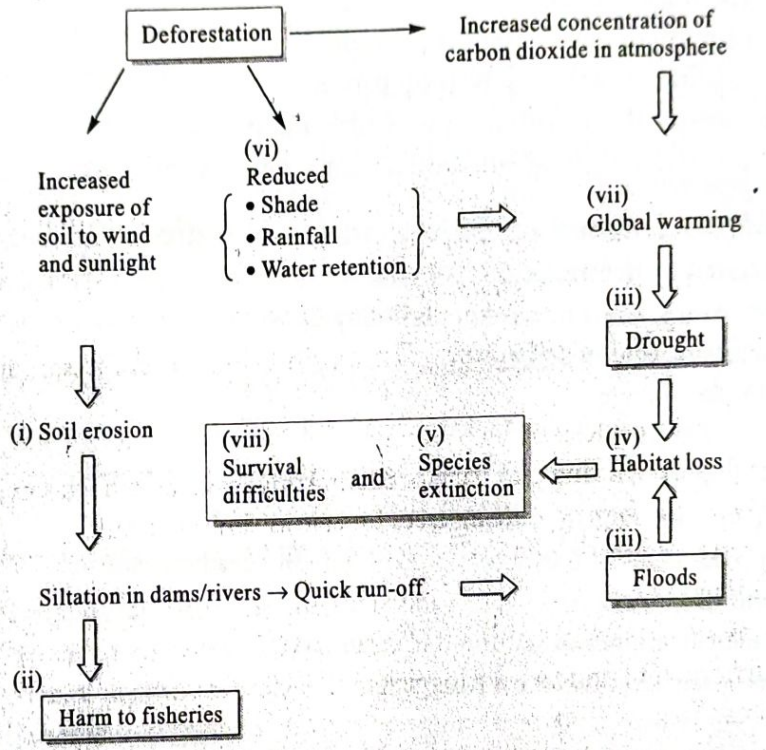

Fig. 2.3 *Effects of deforestation*

(C) Causes of Deforestation in India The deforestation in India is rooted in the commercially oriented forest use and ownership policies of the British government which continued even after India gained independence. (The other cause was the expansion of agriculture.) Immediately after independence, the other major causes of deforestation were

(i) State-sponsored agricultural expansion
(ii) Rapid industrialisation
(iii) Urbanisation
(iv) Growing consumerism
(v) Policies and programmes of unsustainable development like subsidies offered for making the paper and plywood industry a viable and profitable venture

(vi) Lack of education and awareness programmes regarding (a) real cost of the destruction of forests, and (b) legal provisions for the safeguarding of the forests
(vii) Absence of strict implementation of laws
(viii) Not including people at all levels in planning, decision making and implementation (i.e. absence of social engineering)
(ix) Not taking the correct decisions by decision makers on the basis of accurate knowledge and information
(x) The campaign to safeguard forests is not accompanied with social, economic and political reforms
(xi) Corruption of government institutions
(xii) Population growth and overpopulation
(xiii) The inequitable distribution of wealth and power
(xiv) Other causes: shifting cultivation, dams, weather, fires, etc.

(D) Problems Created by Deforestation in India The following problems are created by deforestation in India:

(i) Decreasing levels of rainfall and rainy days
(ii) Increasing rate of soil erosion
(iii) Climate change
(iv) Loss of biodiversity
(v) Air pollution
(vi) Decline in watershed functions
(vii) Apparent loss of hardwood, fuel wood, and aesthetic stocks
(viii) Flooding
(ix) Desertification and sedimentation in rivers
(x) Long-term hydroelectric shortages

Annual deforestation rate is calculated by using the formula (Dirzo, 1992; Vina, 1999; Ochoa-Gaona and Gonzales-Espinosa, 2000):

$$r = \left\{1 - \left(1 - \frac{A_B - A_E}{A_B}\right)^{1/t}\right\} \times 100$$

where r = Annual deforestation rate (%)
t = Number of years for the given period
A_B = Area of forest at the beginning of the period
A_E = Area of forest at the end of the period

- The deforestation trend is assessed by means of Indian topographical sheets and satellite images.
- *The socio-economic drivers of deforestation:* Population density, education, and infrastructure like road creation are socioeconomic drivers of deforestation. This can be confirmed by statistical analysis.

Example 2 *Suppose for a particular area,*
$A_B = 29458.83$ *ha;* $A_E = 21397.96$ *ha;* $t = 10$ *years*
Find annual deforestation rate.

Solution

$$r = \left\{1 - \left(1 - \frac{29458.83 - 21397.96}{29458.83}\right)^{1/10}\right\} \times 100 = 0.315 \times 100$$

Thus, ***deforestation rate = 3.15 % per year.***

(E) Economic Impacts of Deforestation As per BBC News, May 29, 2008; by 2050, damage to forests and other aspects of nature could (a) halve living standards for the world's poor, and (b) reduce global GDP by about 7%.

In developing countries, almost 3 billion people rely on forest wood for cooking and heating. People in developed countries continue to use timber for building houses and wood pulp for paper. In both developed and developing countries the forest products industry is a large part of the economy. By conversion of forest to agriculture, or over-exploitation of wood products, people get short-term economic gains. However, it simultaneously results in loss of long-term biological productivity, and hence a reduction in nature's services.

(F) Environmental Impacts of Deforestation

(i) Atmosphere Less CO_2 taken in, burned trees add even more CO_2, which traps heat, causes more evaporation, and this leads to more precipitation. More sunlight reaches surface, less photosynthesis, increased risk of fire. This is responsible for global warming, which in turn causes deforestation (a).

(ii) Hydrosphere Run-off increases, turbidity increases. More sediment at mouth of rivers, more flash floods.

Increase of water temperature near river banks results in less availability of oxygen in water ways. This is responsible for degradation of aquatic habitat (b) & (d).

(iii) Geosphere Increased erosion from water and wind, top soil carried away, loss of minerals (C, N, etc.), soil depleted quicker, less wood for construction, fuel and other products (b).

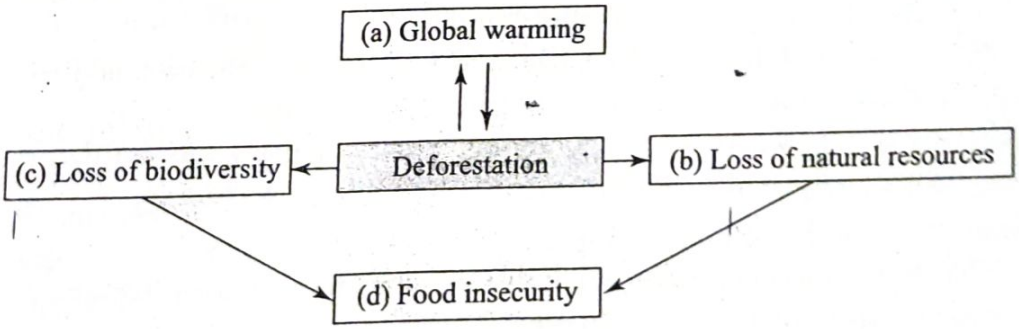

Fig. 2.4 *Problems created by deforestation*

(iv) Biosphere Loss of vegetation, change of food supply, decreased habitat, decrease in number of species, decrease of diversity, decrease of pollinators and seed dispersers, loss of human cultural diversity (c) & (d).

(G) Estimation of Socio-economic and Environmental Impacts of Deforestation The assessment procedure consist of

(i) Description of the environmental state before the deforestation, representing the baseline for assessment; refer (A).
(ii) Identification of the impacts of the deforestation on the environment; refer (B).
(iii) Qualitative environmental assessment and classification of the effects on the environment; refer (C).
(iv) Economic valuation of the environmental impacts, refer (D).
(v) Review for avoiding overlap with other sectors, refer (E).

(A) Goods and services provided by forest ecosystems must be clearly tabulated.

(B) Impact identification requires knowledge of *cause–effect relationship*. For example, More deforestation means more sunlight reaches the surface, less photosynthesis, more CO_2 in atmosphere, global warming and increased risk of fire (Fig. 2.4).

(C) To assess the effects of deforestation on natural capital (i.e. goods and services), one can begin by separating its components: physical medium (air, water, soil, climate), biotic medium (flora, fauna, human beings); perceptual medium (landscape, cultural and scientific resources) and interactions among the above-mentioned media.

(D) Environmental impact can be direct or indirect. Direct damage to the environment can be estimated as the value of the assets effected.
- For permanent destruction, direct damage can be considered as the commercial value of the assets when a market exists for them. For example, if agricultural land is completely destroyed, the direct damage will be the value of the land.
- When afforestation is possible, the direct damage can be approximated by estimating the cost of afforestation.
- When a value cannot be assigned to assets for the estimation of direct damage, estimates must be made by indirect means.

(E) Review the damage estimation for avoiding counting many and varied cases of damage twice under the different social or economic sectors.

Notes:

(1) The above procedure is also applicable for estimating the socio-economic and environmental effects of disasters.
(2) The above methodology takes into account several major constraints, such as:
   (i) too little time available for carrying out the assessment,
   (ii) the lack of information on affected ecosystems, and
   (iii) the shortage of markets for most environmental services.

(H) The Measures Taken for Conserving Forest Wealth

(i) ***Sustainable Forest Management (SFM)*** SFM is the use of the world's forests in such a way that they continue to provide resources in the present, without depriving future generations of their use.

(ii) ***Forest Certification*** Be responsible consumers. Buy wood only from companies that follow sustainable practices.

(iii) ***Involve Local Communities in Joint Forest Management (JFM)*** As local communities want to continue to get the benefits they previously enjoyed, they provide labour and help in conserving biodiversity. The Government should provide them *extractive reserves*. These are protected forests in which local communities are allowed to harvest fruits, nuts, medicines, fibres, rubber, etc., in ways that do not harm the forest.

(iv) ***Improve Governance and Accountability*** The Government must take bold political decisions and develop new civil society institutions to improve governance and accountability regarding forest use. Stop harmful subsidies to timber companies.

(v) ***Accelerate Education, Research and Training*** This is to ensure that SFM and JFM can quickly become a reality.

2.3.3 Timber Extraction

Timber is a term used to describe clusters of trees. It is also used to describe wood throughout its processing from the time it is cut down to the time it is used as a structural material. It is a durable wood of high quality used for making sports goods, doors, window frames, crates, plywood sheets, household utensils, coffins, furniture and other items.

Timber extraction is the removal of timber from forests. It requires various cutting, felling and hauling practices.

Logging is the work or business of felling and trimming trees and transporting the logs to a mill.

(A) Classification of Timber Extraction Methods

Usually, the following types of timber-extraction methods are used:

(i) Clear Felling It is a controversial logging practice in which most or all trees in a harvest are cut down. In clear felling, the aim is to create an even-aged group of trees with commercial species dominating by removal of noncommercial trees by cutting. Thus, clear felling means complete destruction of the native forest. All over the world, industrial timber logging is being done by clear felling.

(ii) Handlogging It involves timber felling by hand-held chain saws. The transport of logs from felling sites to log landing sites is also manual. It is practiced in those forests that are either seasonally flooded or permanently waterlogged (e.g. peat swamp forests). Many local people also use this method for clearing of forests for agriculture.

(iii) Harm to Nature Timber extraction results in forest fragmentation. It promotes loss of biodiversity because some species of animals and plants require large continuous areas of similar habitat to survive.

(iv) Climate Change Removal of forest cover leads to increased spring run-off coupled with summer drought, soil erosion and landslips. This also results in hotter summers and cooler winters.

(v) Soil Erosion and Siltation The tracks made by heavy machinery and the clearings left behind by loggers are sites of extreme soil disturbance. From these sites, heavy rain causes soil erosion. This causes siltation of the streams, rivers and the forests. As a result, the lives of indigenous people, life-support systems and the habitat of hundreds of birds and animals gets disrupted.

Case Studies

(i) Chipko Movement

'*Chipko*' in Hindi means hugging or embracing. Contractors used to make huge profits, from the feeling of trees in the hills. The Chipko movement was the hill communities' response to the unfair and destructive nature of this contract system. The Chipko movement spread through India during the 1970's.

As per the folk-poet Ghansyam Returi, Chipko movement is

"Embrace the trees in the forests and save them from being felled! Save the treasure of the mountains from being looted away from us!"

The slogan of the Chipko movement was

"What do the forests bear? Soil, water, and pure air!"

The Chipko movement ensured that the contract system was abolished and the indiscriminate felling of trees stopped. The Forest Development Corporation (FDC) department was formed which works for the welfare of hilly areas and the people living there. It enlightened the people about the necessity of ecological balance in the nature.

The Chipko movement took place under the leadership of Sunder Lal Bahuguna (an environmentalist and journalist) and Chandi Prasad Bhatt in Tehri Garhwal (Uttarakhand). Sunderlal along with his wife, Vimla, has given his time and talent freely to work for the good of India. He has been the catalyst of change, encouraging thousands of people to work without pay for the good of India's people and ecology, through non-violent resistance. As a Gandhian peace worker, they do not resort to violence to achieve the change.

Chandi Prasad Bhatt encouraged the development of local industries based on the conservation and sustainable use of forest weather for local benefit.

Forests in Uttarakhand district covered more than 81% of its geographical area in 1950. The Government initiated the process of development by allowing a pulp and paper mill, a plywood factory and a chain of hydroelectric dams on rivers. Over-exploitation of forest resources by these industries and submergence of huge forests and agricultural areas by dams resulted in shrinking of the forests

to nearly 25% of the district's area by 1980. The poor, local population was forced to displace. The conversion of the natural mixed forests into eucalyptus and teak plantations dried up the water resources, directly affecting forest dwellers, and resulted in poverty instead of intended development.

The Chipko protests in Uttar Pradesh achieved a major victory in 1980 with a 15-year ban on green felling in the Himalayan forests of UP by the order of the then Prime Minister of India (Mrs Indira Gandhi). Since then, the movement has spread to many states in India. The movement has also helped in stopping deforestation in the Western Ghats and the Vindhyas.

(ii) Appiko Movement

In Karnataka, the Chipko movement is known as Appiko movement, because in Kannada, the local term for 'hugging' is *appiko*. The main objectives of the Appiko movements are:

(a) *Ulisu* (to conserve),
(b) *Belesu* (to grow), and
(c) *Balasu* (rational use).

The importance of the Appiko movement can be understood from the fact that it is trying to evolve a sustainable development strategy for conservation and improvement of forest resources.

In September 1983, men, women and children of Salkani "hugged the trees" in Kalase forest and gave birth to a new awareness all over southern India through this Appiko movement. It uses various techniques to raise awareness like foot marches in the interior forests, street plays, folk dances, etc. As a result of the Appiko movement, the state government has banned felling of green trees in the same forest areas. Only dry, dying and dead trees are felled to meet local requirements.

The Appiko movement is also promoting afforestation on denuded lands. It is also active in promoting rational use of the ecosphere.

(iii) The Bishnois

Jambhoji, a resident of a village near Jodhpur, had a vision in the fifteenth century that the people's interference with nature like felling of trees, killing of animals would result in drought. Thereafter, he become a sanyasi and initiated the Bishnoi sect. He came to be known as Swami Jambeshwar Maharaj. He laid down tenets (including a ban on killing animals, a ban to the felling of *khejri* and other trees) for his followers.

Once the Maharaja of Jodhpur sent his men to the area around the village of Jalnadi to fell the trees as he required wood for building a new palace. When Amrita Devi (a Bishnoi rural woman) saw this, she rushed out to prevent the men and hugged the first tree, but the axe fell on her. Before dying, she uttered the now famous couplet of the Bishnois, 'A chopped head is cheaper than a felled tree'. To prevent the Maharaja's men from felling the trees, people from 83 surrounding villages rushed to the spot and by the end of the day more than 350 had lost their lives.

When the Maharaja heard about this, he was filled with regret and came to the village to personally apologise to the people. He promised them that they would never again be asked to provide timber to the ruler, no *khejri* tree would ever be cut, and hunting of animals would be banned near the Bishnoi villages. The village of Jalnadi thus came to be called *khejari*. The Bishnois have proved that human lives are a small price to pay to protect the wildlife and the forests around them.

(iv) The Green Belt Movement

Dr Wangari Maathai started the Green Belt Movement (GBM) in 1977 as a grassroots tree planting programme to address the challenges of deforestation, soil erosion and lack of water. Now, GBM is one of the most prominent women's civil society organisations, based in Kenya. The GBM advocates for human rights, supports good governance and protects the environment through peaceful democratic change.

In 2004, Dr Wangari Maathai became the first African woman and the first environmentalist to receive the Nobel Peace Prize.

Across Africa, GBM has helped in the plantation of more than 40 million trees. As a result, soil erosion has been reduced in critical watersheds, biodiversity-rich indigenous forests have been restored and protected in thousands of acres, and lakhs of women and their families are standing up for their rights and those of their communities to live healthier and more productive lives through training in forestry, food processing, beekeeping, etc.

In the next decade, the goal of GBM is to plant one billion trees worldwide. A healthy natural world is at the heart of an equitable and peaceful society.

(v) Social Forestry

Thimmakka and Chikkanna were residents of Hulikal village in Karnataka, India, and were childless. Frustrated from the taunts of neighbours for being infertile, they decided to raise banyan (*Ficus religiosa*) trees as their children. Every year, for many years, they planted 15 to 20 new saplings of banyan trees along a hot, dusty 4 kilometre stretch between Huikal and Kudur villages in Karnataka. Every morning, the couple set out—Thimmakka (the wife) with a pot atop her head and another on her hip and Chikkanna (the husband) with two more pots hanging from a pole he held over his shoulder. They watered the tiny plants and placed thorn guards around their little wards to protect them from grazers. They watered the trees everyday till they flourished. They refilled the pots from wells and ponds along they way as their trees required about 50 pots of water a day. They visited their plants at least once a week until the trees were 10 years old.

More than 45 years later, the banyan trees (the adopted children of Thimmakka and Chikkanna) stretch all along the 4 kilometres between Hulikal and Kudur villages. The trees are in fact a proud and memorable mark of their 'parents' dedication. They provide shade for the villagers, who often had to work on the hot and dusty road. Chikkanna died a few years later and after five years, the couple started receiving recognition. Thimmakka has received the National Citizen's

and the Prime Minister's Award for Social Forestry for the strong upbringing of her many offspring.

Thimmakka proved that environmentalism is not exclusively for the wealthy and privileged, but that it should be at the centre of everyone's daily lives without cultural restrictions or economic education.

2.3.4 Mining

Mining is the extraction (removal) of metals and minerals from the earth.

(A) Sustainable Mining Extraction and beneficiation of raw materials has to be

- Environmentally compliant
- Socially acceptable
- Economic

"Sustainable"

A mining operation is socially acceptable if

(i) It obeys standards in occupational safety and health
(ii) It is accepted by the society
(iii) It obeys national and international guidelines and laws
(iv) It provides resettlement help
(v) It considers cultural and social constraints
(vi) It provides suitable working conditions for the workers

A mining operation is economic if

(i) It fulfills the needs of the society with material and immaterial goods
(ii) It is working for the long-term maximisation of revenues and profit

A mining operation is environmentally compliant if

It does not impose any harm to the environment.

(B) Mining Process and the Environment Some of the major environmental impacts of mining are a result of associated mining operations as summarised in Fig. 2.5.

(C) Environmental Impacts of Mining Some of the major environmental impacts of mining are the following:

(i) Ecological Impacts

(a) ***Degradation of Land*** Due to leaching out of toxic elements, the growth of vegetation is adversely affected. Loss of fauna and flora is also observed.

(ii) Socio-economic Impacts

(a) ***Pollution of Water Resources*** Even when drainage is controlled, some leaching and release of harmful elements (e.g. Pb, Cd, etc.) into the surface and groundwater occurs. It affects the ecosystem stability adversely due to alterations in water quality and availability.

(b) ***Pollution of Air*** Mining processes emit dust and gases which cause air pollution. These air pollutants have adverse impacts on historical monuments and religious places.

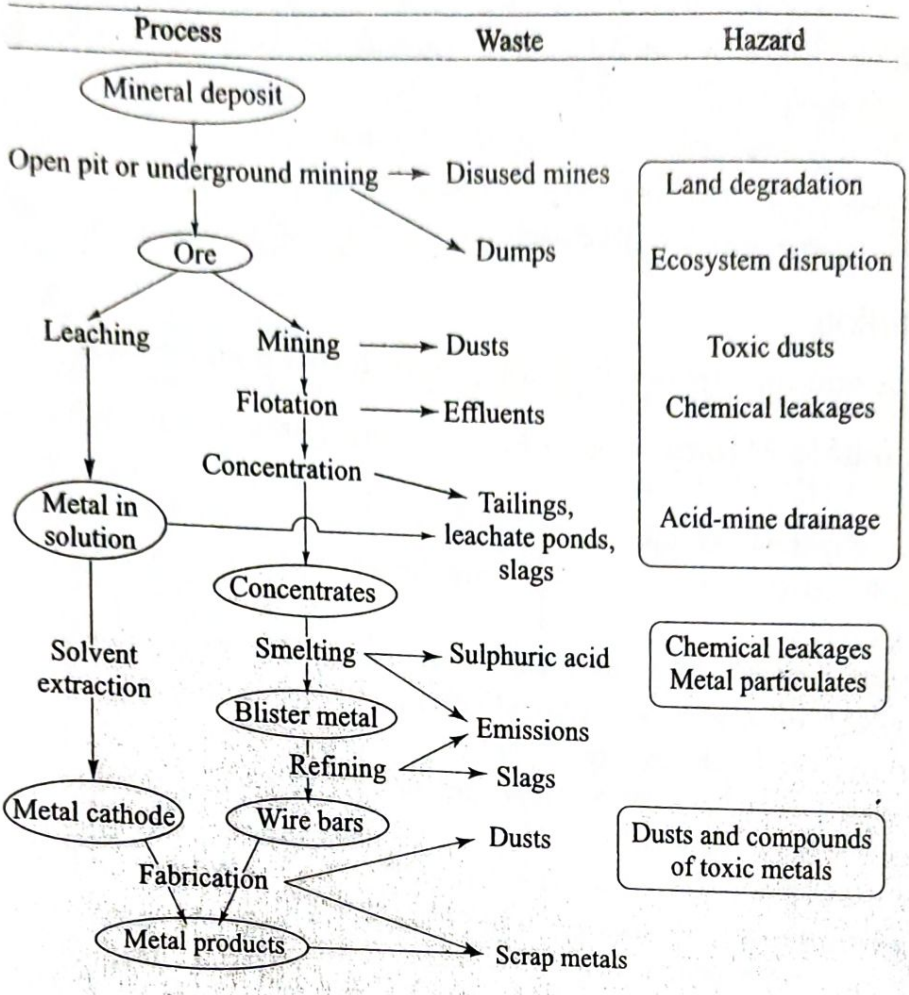

Fig. 2.5 *Mining process and the environment*

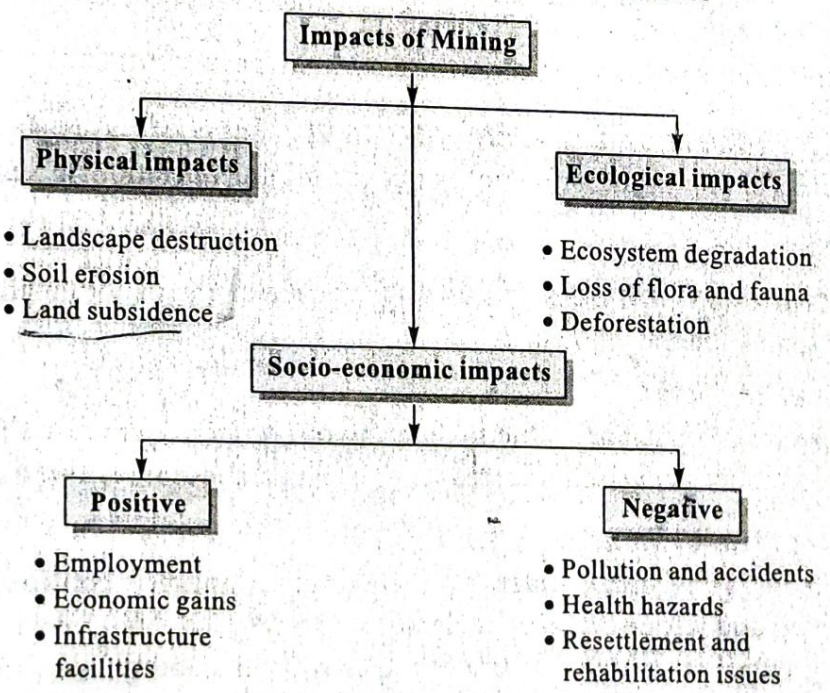

Fig. 2.6 *Impacts of mining activities*

(c) ***Problems in Rehabilitation of Affected Population*** It is one of the biggest problems due to economic constraints.

To sum up,

Mines always cause environmental impacts
But ... it is usually cheaper to prevent the impacts than to deal with them after they have already happened. It is easier to prevent the impacts if one knows about them in advance.

Case Studies

(i) Impact of Coal Mining on Vegetation

Meghalaya, one of the seven states of North-East India, is honoured with rich natural vegetation as well as large reserves of mineral resources.

In the early 1970s, coal mining was initiated in the Jaintia Hills district of Meghalaya. Since then mining and the area affected by it is increasing day by day. The dense forest areas were converted into open forests and the considerable area of the forests was converted into a nonforest.

Extensive coal mining has led to landscape damage and damage to the biological communities in enormous ways. The number of trees and shrub species drastically decreased due to mining. The unfavourable habitat conditions prevailing in the coal-mining areas has reduced the chances of regeneration of species, thereby, reducing the number of plant species in the mined areas.

(ii) Jhansi Open-Cast Mining Site: Uttar Pradesh, India

The Bundelkhand region occupying about 71818 km^2 in Uttar Pradesh is known for its rich deposits of graphite, saltpetre, sand, etc. Presently there are around 325 active mining sites in the Jhansi district alone (2010).

Mining and its allied activities significantly contributed towards infrastructure development and raising the living standards of the people.

Deforestation, dust generation, noise, air and water pollution as well as resource depletion are common hazards associated with open-cast mining widely prevalent in the Jhansi region.

(iii) Marble Mining and Drying of Lakes in Rajasthan

The Aravalli Hills are the lifeline of Haryana, Rajasthan, and Gujarat. They control the climate and drainage systems of the region. The hills also act as a watershed for the region. The hills are also known for their rich deposits of teak, marble and granite. About 1,75,000 workers are employed in mining and related industries. About 9700 industrial units are connected with mining in Rajasthan alone.

Over the past 20 years, the forest cover has been depleted by 90% in Rajasthan due to large-scale mining. When the mines reach below the underground water level, a cone of depression is formed that sucks water from the surrounding areas, drying up wells and lakes and affecting agriculture.

The Rajasamand Lake in Rajasthan had not dried up for at least 300 years. However, in 2001, this finally did happen because of a decade of marble mining in the Rajnagar area. While mining has led to the depletion of water, mining waste has destroyed fertile land.

(iv) Impact of Mining Activities on Labourers

Studies on mining activities in the Aravallis have shown that

(a) Labourers are not provided with any health care
(b) Tuberculosis, silicosis and other lung diseases are very common
(c) Diseases make labourers invalid and even kill them by the age of 40
(d) The condition of women workers (30–40%) and child labourers (10–15%) is the worst.

(v) Impact of Mining on the Culture and Lifestyle of People

From the gold and copper project, 1000 m^3 of conc. cyanide were released into a river in 1984 on the OK Tedi Island in new Guinea. It caused extensive environmental damage, devastated the ecosystem and destroyed the culture and lifestyle of the native Wopkaimin people.

2.3.5 Dams and their Effects on Forest and Tribal People

A *dam* is a huge and giant barrier constructed across a river to obstruct its natural flow. Consequently, an enormously large artificial lake is created to store water. The water thus stored is utilised for multipurpose services such as power generation, irrigation, flood and drought control, etc.

Construction of dams in countries like India and China displace a large number of people because of the high population densities of these countries. In India, dams account for 75–80% of displacement of about 4–5 crore people. Out of the total people displaced, only 25% have been rehabilitated so far. Tribal people are economically, socially and politically the weakest and the most deprived community in India.

Some of the problems associated with effects of dams on tribal people are listed below:

(i) ***No Human Rights*** Human rights violations create unrest among tribals.

(ii) ***No Basic Amenities*** They are forced to migrate to urban slums in search of employment. They become landless labourers in rural areas. A majority of tribal people end up with less income than before, less resources of the common people, inferior houses, etc. They are forced to live without drinking water, sanitation, health care, and other basic amenities.

(iii) ***No Benefit Sharing*** They hardly get to share the benefits of development projects that cause their displacement.

(iv) ***No Home*** Tribal people have been forced to leave their ancestral homes and go elsewhere.

(v) ***No Cultural Identity*** Tribal communities get dispersed, traditional support systems get broken and cultural identity gets devaluated because of dams.

Table 2.4 *Problems associated with effects of dams on tribal people: Loss of*

R	A	S	H	I
↓	↓	↓	↓	↓
Rights	Amenities	Sharing	Home	Identity

All major dams are constructed in mountainous regions, where there is plenty of rainfall. These places are covered with rich vegetation and forests.

The major effects of dams on forests are summarised below:

(i) The forests area which is supposed to get submerged is cleared off by the contractors.

(ii) The forest is also cleared for approach roads, offices, residences and for storage of construction material.

(iii) As more and more workers occupy the dam sites, forests are destroyed for getting fuel and timber.

(iv) ***Irrecoverable Loss to Ecosystems and Biodiversity*** Forest fragmentation causes serious irrecoverable loss of species and ecosystems. This is because some species of animals and plants require large continuous areas of similar habitat to survive.

2.4 WATER RESOURCES

Water resources are sources of water that are useful or potentially useful to humans.

Water is a prerequisite for the existence of life. Plants, animals, and human beings cannot survive without water. Water is used in agricultural, household, industrial, recreational and environmental activities. Water is essential for economic growth, environmental stability, biodiversity conservation, food security and health care.

(A) The Water Cycle It describes the continuous movement of water above and below the surface of the earth. It is driven by the sun.

The sun heats water in seas and oceans. Water evaporates into the air as water vapour. Snow and ice can sublime directly into water vapour. Rising air currents take the water vapours into the atmosphere where cooler temperatures help them to condense into clouds. Air currents move clouds; they collide, grow, and fall out of the sky as precipitation. Some precipitation falls as snow, and can accumulate as ice caps and glaciers . Most water falls back into the oceans or onto land as rain where the water flows over the ground as surface run-off. Much of the run-off is soaked into the ground as infiltration. Some run-off is stored as fresh water in lakes. Some run-off enters rivers in valleys in the landscape. Some water infiltrates deep into the ground and replenishes aquifers. This helps in the long-term storage of freshwater. Some groundwater finds openings in the surface of land and freshwater springs come out. Some rainwater flows through rivers back into the ocean, where the water cycle begins again.

Table 2.5 *Water cycle*

Significance of Water Cycle	*Problems Arising from the Disturbances to the Water Cycle*
(i) The water cycle helps in the maintenance of life and ecosystems on the earth.	(i) Maintenance of life and ecosystems on earth get disturbed.

(Contd.)

are threatened with extinction. In India, about 450 species of plants, 150 species of mammals and 150 species of birds are considered to be endangered. Besides these some reptiles, carnivorous mammals and primates are also treated as endangered.

Depending upon the danger being faced species may widely be classified into four groups:

1. Extinct species: When a species is not seen for 50 years at a search, it is said to be extinct species. e.g. dodo, passenger pigeon.

2. Endangered species: Species whose number has been reduced to a critical level or whose habitats have been reduced drastically are called endangered species. If not protected, they have an immediate danger of extinction. e.g. plants like Bentinckia nicobarica, animals like Ailurus fulgens.

3. Vulnerable species: Species whose population is continuously declining due to over exploitation or habitat destruction are known as vulnerable species. This type of species are still abundant but are under a threat of extinction if the otherwise factors are not checked, *e.g.* plants, like Cupressus cashmeriana and animals like Antelope cervisacapra.

4. Rare species: Species which are not endangered or vulnerable at present but have a risk of being vulnerable are called rare species.

➢ ENDEMIC SPECIES OF INDIA

The species restricted to a definite area only for their distribution are known as endemic species. In other words, these are found in a single locality. The definite area occupying endemic species may be a continent or a country. Due to their abundance in a particular area, they have unique characters and values. The endemism of Indian biodiversity is quite high. Out of 47,000 plant species in India, 7,000 are endemic. About 62% endemic flora is restricted mainly to Himalayas, Khasi hills and Western Ghats. In addition to plants 81,000 species of animals in our country are endemic. About 62% amphibians and 50% lizards are restricted to Western Ghats.

Some of the important endemic species of India are:

Plants: Orchids, Sapria himalayana, Uvaria lurida, Nepenthes khasiana, Pedicularis perroter, Butea, Pedalium, Sesamum indicum, Piper longum, etc.

Animals: Lizards, reticulated python, Indian Salamander, Nectophhryne, etc.

➢ CONSERVATION OF BIODIVERSITY

The management of human use of biosphere so as to receive greatest sustainable benefit to the present generation and maintaining its potential to meet the needs and aspirations of future generations is known as conservation of biodiversity.

Conservation process performs the following functions:

1. Maintenance of essential ecological processes and life-supporting systems.
2. Preservation of diversity of species.
3. Sustainable utilisation of species and ecosystem.

As discussed above, the value of biodiversity is continuously declining due to different reasons. Hence, to lead a sustainable life and balance between the living beings and their environment, it is necessary to conserve this depleting biodiversity.

Loss of biodiversity is of great concern to India since many plant and animal species are severely threatened by the destruction of their habitat and an over-exploitation of resources. A large number of species are either endangered or on the verge of extinction, both of which can be attributed to a lack of policy and institutional mechanisms including comprehensive policy guidelines for biodiversity conservation, biodiversity legislation, participation of communities, and a clear perspective on intellectual property rights leading to international patents on Indian biodiversity. Strategies and actions required to protect India's rich bio-wealth are as follows :

* Most of the legal provisions focus on the use and exploitation of biological resources rather than their conservation. Even the Wild Life Protection Act 1972, focusses on protection and not on conservation. Hence a greater thrust should be given to conservation.

* A comprehensive legislation on biodiversity conservation and uses should be promulgated.

* Formulation of policies for the protection of wetlands, grasslands, and sacred groves significant from the point of view of biodiversity.

* A biodiversity bill should be immediately passed but the Biodiversity Act/Bill should not over-ride the provisions of Wildlife Protection act.

* The country needs to urgently finalise a comprehensive biodiversity strategy and action plan that will provide an overall assessment of the current state of India's biodiversity and concrete steps, mechanisms and guidelines to develop institutional structures for its implementation.

* There should be a continuous monitoring of biodiveristy use in order to review the results of the implementation of policies and programmes.

Conservation of biodiversity in India : Conservation and sustainable use of biological resources based on local knowledge systems and practices is ingrained in Indian ethos and way of life. Initiation of policies and programmes for conservation and sustainable utilisation of biological resources date back to several decades. As a result, India has a strong network of institutions mapping biodiversity and undertaking taxonomic studies. The Botanical Survey of India (established in 1890) and the Zoological Survey of India (established in 1916) are primarily responsible for survey of flora and fauna. The National Institute of Oceanography and several other specialised institutions and universities further strenghten the taxonomic data base. Based on the survey of 70% of the total geographical area of the country, 46,000 species of plants and 81,000 species of animals have been recorded so far. These life forms are actually and potentially important for development in the fields of food, medicine, textiles, energy, recreation and tourism. The areas not yet surveyed include the inaccessible Himalayan area, Andaman and Nicobar Islands and Exclusive Economic Zone. These areas are expected to be rich repositories of endemic and other species.

Two different approaches have been proposed for the conservation of biodiversity:

1. In-situ conservation. 2. Ex-situ conservation.

1. In-Situ conservation: Conservation of species in its natural residing place is known as in-situ conservation. It may be the natural ecosystem or the artificial one. This type of conservation is applicable only to wild fauna and flora and not to domestic animals.

Approximately 4.2% of the total geographical area of the country has been earmarked for extensive in-situ conservation of habitats and ecosystems through protected area network of 85 National Parks and 448 Wildlife Sanctuaries. The results of this network have been significant in restoring viable populations of large mammals such as tigers, lions, rhinoceros, crocodiles, elephants, etc.

In this type of conservation, certain protected areas are developed which help in providing shelter to the endangered species. The areas of land or sea especially dedicated to the protection and maintenance of biodiversity and natural and cultural resources are known as protected areas. Protected areas have the following benefits:

(i) Maintenance of viable population of all native species.
(ii) Maintenance of number and distribution of communities and habitats.
(iii) Conservation of genetic diversity.
(iv) Prevention from alien species.

Protected areas may be in three forms:

(i) Biosphere reserves
(ii) National parks
(iii) Wildlife sanctuaries.

(i) Biosphere reserves: The concept of biosphere reserve was started in 1975 under the 'Man and Biosphere' Programme of UNESCO. In this concept, the multiple land use is permitted and the biosphere is not restricted to any one, two or more species, but to the whole ecosystem. Thus, biosphere is ecosystem oriented.

A biosphere reserve consists of:

A. Core area: Core area is central undisturbed and legally protected ecosystem.

B. Buffer area: Buffer area surrounds the core and permits limited human activities, as education and research.

C. Transition area: It surrounds the buffer area and permits the active cooperation between management and local people.

Biosphere reserve performs the following functions:

A. Conservation of ecosystem, species and genetic resources.

B. Economic development while maintaining the cultural, social and ecological identity.

C. Promotion of research related to monitoring and education.

Important biosphere reserves of India are:

A. Nanda Devi (U.P.)
B. Nokrek (Meghalaya)
C. Manas (Assam)
D. Sunderbans (West Bengal)
E. Gulf of Manna (Tamilnadu)
F. Nilgiri (Karnataka, Karela, Tamilnadu)
G. Great Nicobars and Similipal (Orrisa)

(ii) National parks: The areas dedicated for the conservation of wild life along with its environment are called national parks. National parks are meant for the betterment of wild life and grazing, foresting or cultivation is prohibited in these areas. Important National parks of India are:

A. Kaziranga (Assam)
B. Gir National Park (Gujrat)
C. Dachigam (J&K)
D. Bandipur (Karnataka)
E. Periyar (Karela)
F. Kanha (M.P.)
G. Corbett (Uttranchal)
H. Dudwa (U.P.)
I. Ranthambore (Rajasthan)
J. Sariska (Rajasthan)
K. Rajaji (U.P.)

(iii) Wild Life sanctuaries: Protected areas for wild life, where harvesting of timber, collection of minor forest products and private ownership rights are permitted, provided they do not affect or interfere with the well being of animals, are known as wild life sanctuaries.

Important wild life sanctuaries of India are:

A. Ghana Bird sanctuary (Rajasthan)
B. Hazaribagh sanctuary (Bihar)
C. Sultanpur Bird Sanctuary (Haryana)
D. Nal Sarovar Bird Sanctuary (Gujrat)
E. Abohar Wild life Sanctuary (Punjab)
F. Mudamalai Wild Life Sanctuary (Tamilnadu)
G. Vedanthangal Bird Sanctuary (Tamilnadu)
H. Jaldapara Wild Life Sanctuary (West Bengal)
I. Wild Ass Sanctuary (Gujrat)

2. Ex-situ conservation: Conservation of species away from their natural habitat is called ex-situ conservation. This type of conservation is mainly adopted for the conservation of crop varieties, wild relatives of crops and all the local varieties. They include botanical gardens, zoos, conservation stands for gene, pollen, seed, seedling, tissue culture, and DNA banks. Attention has been paid to *ex-situ* conservation measures also as they complement the *in-situ* conservation and are even otherwise important. There are about 70 botanical gardens including 33 University Botanical Gardens. Also, there are 275 centres of *ex-situ* wildlife preservation in the form of zoos, deer parks, safari parks, aquaria etc. A Central Zoo Authority supports, oversees, monitors and coordinates the management and the development of zoos in the country.

Steps involved in ex-situ conservation: (i) Establishment of minimum target population goals to provide for maintenance of captive genetic diversity.

(ii) Distribution of founders through various captive breeding programmes.

(iii) Circulation of compiled programmes to all breeding facilities.

(iv) Implementation of an overall plan contributing to the objectives of maintaining viable populations across the globe.

Advantages of ex-situ conservation: (i) Assurance of food, shelter and security to the organism.

(ii) Increase in life span and breeding activity.

(iii) Increase of chances of survival.

(iv) Possibility of use of genetic techniques to improve concerned species.

Disadvantages of ex-situ conservation: (i) It can be adopted only for a few species due to limitation of space, finance and facilities in the institutions undertaking captive breeding.

(ii) Deprival of opportunity by organism to adopt to the ever-changing natural environment.

Following are the important steps found to be helpful in conservation of biodiversity :

1. Expansion of the protected area network : Maintaining viable populations of species, whether plant or animal, is a crucial factor in biodiversity conservation and this requires the appropriate conservation of important ecosystems and habitats. Currently, the country has 88 national parks and 490 sanctuaries.