CHAPTER VI
ENVIRONMENTAL ASPECTS

“When the Well is Dry We Learn the Worth of Water” - Benjamin Franklin.

The Lower Yamuna Valley is endowed with valuable natural resource like water, soil and wide variety of landscpic morpho-units. The physical landscape is shaped by a variety of micro-climatic conditions. The scenic beauty of the landscape and vast natural sources are being destroyed by natural (including biotic factors) and unnatural (abiotic factors) causes. “The rich out of greed and the poor out of need are plundering the Mother Earth. It must be remembered that there is enough with Mother earth for everyone’s need but very little for their greed. Every person must always remember that the present generation has inherited the Mother Earth for the safe keeping for their offspring.” These immortal quotes of Mahatma Gandhi, Indira Gandhi, and Shri Rajiv Gandhi must always be remembered by all. The rich resources have not been fully and scientifically utilised for the benefit of the local and national economy.

There are a number of lacunas in the present system of utilization of the natural resources. Hence the need to evolve conservation based strategy for their optimum use in a way that they continue to be available for use on a sustained basis. Under the environmental aspects land resource

6.1. Water Resource Depletion

In the Yamuna valley during heavy rains, the hills are unable to quickly absorb the vast quantity of water that pours down within a short time and so most of it is wasted by the way of excess of surface run-off. Thus, flash floods occur in the raos and a huge quantity of water pours down them, eroding lands lying along their banks. This also leads to the deposition of a large amount of debris on agricultural lands, forests, pasture lands, etc. These sediments support a scrub type of vegetation as in most cases there are too many boulders to make them suitable for even the crudest form of cultivation. In their upper reaches, the raos are forming badland topography. Their erosive capacity is enhanced by the fact that -
- The country rocks are partly comprised of unconsolidated sediments.
- The load of these water courses is fairly large.
- The area has undergone considerable tectonic disturbances due to the intense mountain building processes that are at work even today.

At times, due to changes in hydrological conditions, the raos may change their course. This leads to widespread destruction as large chunks of valuable lands are engulfed. Examples of this phenomenon can be seen near the influence of the river Bata with the river Yamuna. The raos have carved out large gullies. In some tracts lying along the Siwalik water-divide, they have scoured steep cliffs. Under cutting of such cliffs leads to the weakening of its base, whereby landslides are produced. In some tracts buttresses of the Siwalik hills are found in the raos sediments. Such formation appeared to have resisted erosion through edges. Wide deposits, brought down by the raos are found near water gaps and these become narrower as one proceeds away from them. As it cuts through the water gap, a raos assimilates the discharge of all its tributaries ad thus maximum erosive and transportation capacity is developed. Large deposits of unsorted sediments are formed at the junction of two raos sediments.

The problem of erosion along raos is further increased by overgrazing, overlopping and the general disturbances by the ecosystem that has set in, in the catchment area of these streams.

6.1.1. Rill and Gulley Erosion: Primarily due to overgrazing, overlopping and other means of biotic interferences, the lower northern Siwalik slopes and lower Lesser Himalayan slopes have become pock marked with ugly looking repulsive scars. Thousands of goats, sheep and cattle graze upon the forests of this tract. Their hooves scour the soil, causing accelerated erosion. Moreover, who live in the adjoining areas have to depend on forest for their daily need of fuel, fodder and timber. This has led to reduction in the capacity of these forests to act as a brake against accelerated erosion.

As a result, in the initial stage countless fingers like features are produced. This is rill erosion. Due to continued accelerated erosion these rills widen to become huge gullies. Such features are very common on the lower slopes on the Siwalik hills and the Lesser Himalaya (fig. 6.1). The formation of gully is aided by the fact that the area is dissected by number of streams and there is a thick pile of unconsolidated sediments in
the northern phase of Siwalik Hills. Thousand of tons of sediment are washed away each year from these gullies. This usually comprises of valuable top soil and sub-soil that is subsequently deposited over wastelands and even agricultural fields.

![Formation of gullies due to road cutting and landsliding.](image)

**Fig 6.1:** Formation of gullies due to road cutting and landsliding.

**6.1.2. Water Pollution:** Amongst various forms of pollution, water pollution is the most serious problem affecting the Himalayan environment. Many water bodies like the Dal like, Nainital lake, Sirsa river and Yamuna river have been polluted. The main causes responsible for water pollution in Himalayan water bodies are

(a) Inflow of silt.
(b) Release of sewage and domestic waste.
(c) Release of industrial effluents.
6.2. Water Resource Conservation:
The present haphazard utilization of supply of water accentuated by the development of forest, mineral and agro-based industries as also by power generation, demands maximum rational utilization of available hydrolic resources. A thorough investigation of the area reveals that out of the total rainfall about 50% is spent in the evapo-transpiration and infiltration processes, about 25% flows as surface run-off every year which is used in agriculture and domestic purpose. But 25% water flows unused. This unused water of the valley can be channelised through the minor canals to fulfill the need of irrigation. It is proposed that suitable minor canals, wheel shifter and pumping sets can be used for minor irrigation and maximum utilization of water.

On the basis of the above study of the available resources and their conservation measures are suggested.

(i) In the Lesser Himalaya region it is proposed to cultivate fruit plantation of lichi, guava, citrus, apples, etc. and afforestation by sal, pine, cedrus and Agave sislana, to practice contour cultivation and to set up the watersheds and torrent control projects. The middle and lower part of Yamuna valley is more suitable for fruit cultivation than the higher reaches which are not suitable for growing the plants because of their adverse climatic conditions. In the lower reaches and on the valley sides water-mills, wheel shifters (Saxena, 1975) and canals, can be constructed. These are proposed on the basis of the high gradient and huge supply of water. Further, soil, mineral and forest depletion can be checked by the above measures.

(ii) The colluvial terraces with high gradient and fair supply of water can well be utilized and conserved by adopting the above measures, besides the plantation and crop rotation of commercial crops like soyabean and sunflower. channel and terrace cultivation is also proposed in this tract.

Based on the topographic, vegetative and soil surveys (Fig. 2.1) of the region corrective plan consisting of mechanical and vegetative measures should be prepared and implemented. Mechanical measures like gabion, cross barriers/check dams and silt detention basins in the lower and middle reaches and log wood crib structures (stone, brush wood filled ) and loose rock filled check in upper reaches for grade stabilization.
Gabion spurs/toe/retaining and side walls should be provided for streams lining of the flow and bank protection in the lower reaches

6.2.1. Water Bank
Majestic Himachal Pradesh and Uttarakhand, their glacial peaks and verdant valleys hold an age-old ecological secret is a major ‘water bank’ for north India: its glaciers comprise a perennial source of water. The States are largely made up of mountainous areas cloaked by forests, which cradle many rivers and natural water sources. These natural sources have given life to civilization nourished by rainwater, which is the biggest source of water on this planet. How rich the State is in this precious resource is underlined by an ongoing official count that has revealed such water sources in half the forested area of Himachal Pradesh that has been covered so far. Even today 90 percent of hill agriculture in the State is dependent on these rainfed sources/ and many villages depend on surface and rainwater for drinking purposes and irrigation.

Water management is a major component of natural resource management/ as water is one of the most important natural resources for the survival of the human race. The main uses of water in the Himalayan region are-
(a) For domestic uses such as for washing, drinking, cooking food etc.
(b) For livestock.
(c) For irrigation
(d) For generation of electricity.

6.2.2. Traditional Systems: Traditionally many systems have been evolved by the local communities for sustained use of the water resources in the Himalayan region. These include the following-
(a) Small channels for conducting the water over long distances, e.g. kuhls of Kangra district in Himachal Pradesh.
(b) Wells.
(c) Farm ponds for rain water harvesting.
(d) Very small temporary dams or walls across the flow of streams in the winter and summer season.
Harnessing the water of small streams for water mills.

**Approaches:** In the recent decades, scarcity of water has become a major problem in many parts of the Himalaya, particularly in summer months. In many villages, even drinking water is not available and has to be bought from far-away places, thus adding to the misery of the local population, mainly womenfolk. It is thus important to conserve water and add to the ground water table. The water use, conservation and management practices, which may be adopted in the Himalayan region, have been described in brief below:

(a) Moisture conservation.
(b) Increasing percolation of rainwater and snowmelt waters into the soil.
(c) Rainwater harvesting.
(d) Sub soil water harvesting.
(e) Harvesting perennial flows.

(a) **Moisture Conservation**

Moisture conservation plays a pivotal role in water management of the Himalayan region. It involves using practices aimed at increasing the seepage of rainwater into the soil so that it adds to the underground water reservoir. The common moisture conservation practices are:

1. Contour bunding on fields.
2. Terracing.
3. Contour trenches.
4. Dams constructed mainly for harvesting rainwater and surface flows also increase percolation into the soil and thus help to conserve moisture.
5. Farm ponds.

(c) **Rain Water Harvesting**

A considerable quantity of rainfall is received in most Himalayan regions, though much of it flows as surface runoff and remains unavailable for human use, livestock and
minor irrigation. The surface flow also causes considerable erosion from unprotected slopes. Over the past centuries, methods have been evolved by the local communities to harvest this rainwater. The modern concepts of rainwater harvesting are largely based on the traditional systems. Various methods, which may be used, for rainwater harvesting, leading to efficient utilization of water resources have been discussed in brief below:

1. **Ponds:** Farm ponds are traditionally constructed for harvesting of rainwater in many parts of the Himalayan region. This water is used for drinking by livestock and also by human beings for minor irrigation and washing. These are small dug out ponds made by excavating earth and rocks at suitable sites, with catchment large enough to fill them in the monsoon season.

The bottom or floor of these ponds is of impervious soil so as to retain the water in the pond. This water is available throughout the remaining part of the year for use by livestock, minor irrigation and also for washing. The ponds need de-siltation after every few years.

2. **Small Dams:** Small dams either earthen or concrete are constructed at suitable locations in the lower hills and Shiwalik tract across the flow of minor streams to impound the water so as to make it available in the dry season for use by human beings, cattle and also for minor irrigation. Their height is usually less than 10 mts though larger structures may also be constructed depending on the technical suitability of the design and site conditions.

Different types of small dams used for harvesting rainwater are:

(a) Earthen dam
(b) Rubble masonry dam.
(c) Concrete dam.

The dam is constructed as far near the head of the channel as possible depending on the available pondage, geology and soil. It is designed to sustain the highest flood level expected in the next 15 to 20 years. Larger structures may be
designed for high flood levels of more than 25 years. Suitable arrangements are made to prevent the scouring action of the surplus water that flows down the apron. Cut-offs are provided to check seepage and washouts from around or under the dam. The location of structures is decided after carrying out preliminary geological studies, with dams not being constructed where the underlying beds have slopes in the direction of flow of the water. The dam is constructed over hard rocks, with the soil cover being removed.

These dams also help in increasing the seepage of water into the ground, reducing floods and conserving the soil.

(d) Sub Soil Water Harvesting

Sub-soil water harvesting is done in the Siwalik and Lesser Himalayan hills by constructing a head wall across the flow of streams for tapping the sub-soil flow. The head wall is constructed till an impervious layer is reached. The sub-surface flows are blocked by the head wall and with the lower layers being impervious, the water is forced to rise. An inlet is made in the form of a tank. It leads to the outlet pipe for taking the water away from the structure. The outlet pipe empties in a storage tank from where the water is conducted to the fields.

These structures are also known as Makkowal type of structures and are constructed of concrete. Suitable structures may be constructed in the upstream ide for protecting the main headwall.

(e) Harvesting Perennial Flows

In many locations, perennial flows may occur in small channels, either throughout the year or for most parts of the year. This water is harvested by erecting a dam across the flow. These dams resemble the ones constructed for harvesting rainwater. They may be of the following types:

(a) Earthen dams.
(b) Rubble dams.
(c) Concrete dams.
6.2.3. Efficient Water Use

Efficient water uses essentially means conserving the water resources so that they can be used more efficiently and remains available for a longer period of time. This includes the following:

1. Judicious use of water.
2. Harvesting of rainwater, surface and subsurface flows.
3. Adoption of water saving practices like drip irrigation and sprinkler system for irrigation.
4. Participatory approaches to water management. This includes management and, use of water through the local community.

6.2.4 Unsustainable Consumption

Ironically, today, the people of these mountainous areas are in the vice-like grip of water scarcity. Over time, people have suffered as the pattern of water use has drastically altered due to development activity spurred by indiscriminate land management policies. This has resulted in an unsustainable demand for water, soil erosion in watershed areas, increased silting of rivers and streams, and depletion of groundwater reserves due to pollution of surface water. What the Government should do? Moreover, how do we meet the drinking water and other demands of an increasing population, and increase food grain production from 1.79 million tonnes (1999-2000) to around 2.5 million tonnes by 2025 AD?

6.2.5. Towards Sustainable Water Resource Development and Management

The need of the hour is sustainable water management, especially in the context of meeting the demands of an increasing population. Simply put, it means managing our finite water resources for present needs while keeping in mind the future requirements of present children and their children. It implies a holistic appraisal of prevailing political, socio-economic, cultural and environmental factors underpinning the abuse of...
this precious natural resource and creating a new yardstick of water management based on the principles of social justice and equity. It also means looking at fresh water as an exhaustible, natural and essential resource, and seeing watershed areas as sustainable units of water resource development and management.

6.2.6. Action Plan for Water Mission:
The Himachal Pradesh government has done its share of introspection and started on a multi-pronged Water Mission to set up an institutional mechanism for watershed planning water harvesting and conservation in Himachal Pradesh.

A State level Committee on Watersheds, a Task Force Committee, a Watershed Development Directorate has been created. The Directorate should ordinate various departments linked to water use, such as forest, agriculture, rural development, drinking water, irrigation, minor-irrigation and energy among others.

An advisory Technology Transfer and Research Committee, comprising of representatives of universities and technical institutions in Himachal Pradesh has been created to acquaint the State level Committee on Watershed with state of the art technologies for its Watershed Development Programmes.

Working to an Action Plan prepared by the Task Force Committee, we have initiated a comprehensive process that includes the:

- Creation of an exhaustive database of the status and source of water resources under the aegis of the Forest Department, Department of Drinking Water, Jal Nigam, Jal Sansthan, and Minor Irrigation Department.

- Formulation of a rationalised State Water Policy on water use, allocations and differential tariffs following comprehensive workshops organised by the concerned departments of Urban Development, Drinking Water, Jal Nigam, Jal Sansthan, Irrigation, and Minor Irrigation.

- Launch of intensive awareness campaigns for optimum water utilisation and management through publicity campaigns, school contests and folk songs among
others, developed by the concerned departments of HPDASP, Swajal, Watershed Management Directorate, and Agriculture.

- Compilation of Information on different techniques of water collection, conservation and harvesting as well as dissemination of the same through training programmes conducted under the aegis of the departments of HPDASP I Swajal State and Central technical institutionsl and known government organisations.

- Creation of model demonstration projects highlighting best practices through the:

  a. Development of one model watershed in each district by the departments of Agriculture and Watershed Management Directorate in collaboration with Central Soil and Water Conservation Research and Training Institute.
  b. Implementation of water harvesting and conservation programmes in at least one Development Block of each of the districts and more Development-Blocks in the water scarce districts with technology demonstrations by the Department of Agriculture.

- Selection and implementation of water conservation and water harvesting programmes in water scarce villages by earmarking 15 per cent of the rural empowerment allocation funds and 45 per cent of funds under all ongoing Watersheds Development Programmes for that purpose I by the concerned Departments of Rural Development (DRDA)I AgricultureI and the Watershed Management Directorate.

- Linkage of water conservation programs with income generating activities like cultivation of off-season vegetables floricultural cultivation of medicinal and aromatic plants fisheries etc. This is to be put into practice by the departments of Watershed Management Directoratel HPDASP I Rural Developmental Swajal and Horticulture.
- Preparation of policies, programmes and technology for ground water, recharge, as well as water quality monitoring, with the help of Central Ground Water Board, with the projects to be implemented by the State Department of Irrigation and Ground Water.

- Protection and Conservation Plan for glaciers, water reservoirs and major rivers, to be formulated and implemented by the Department of Forest and Environment.

6.2.7. Focus on Water Collection and Harvesting:

Under the Sampoorna Gramin Rozgar Yojna (SGRY) in 'water scarce' villages, 50 percent of all employment schemes are being spent, on works related to water harvesting. Government has made a provision for all gram and kshetra panchayats, too, to spend at least 50 per cent of their funds on water harvesting schemes. The money is being spent on making roof harvesting structures (for domestic use after purifying rainwater)! tanks! check-dams and ponds for irrigation. Efforts are being made to research traditional water harvesting ways.

In urban areas with bigger population pressures, all construction plans, residential! commercial, institutional or governmental, will get clearance only on providing facilities for rainwater collection. Work is afoot to amend the building by-laws to enable the construction of water harvesting structures.

6.2.8. Models of Best Practices of Water Harvesting:

(i) The construction of 114 ferro-cement tanks with a total 2 lakh litre capacity, by the Soil Conservation Department, meets the total non-drinking water requirements.

(ii) The Soil Conservation Department restore rain water harvesting with roof-top devices.

(iii) Commercial model can use 2.65 lakh litres of water collected in six roof-- top tanks to meet its non-drinking requirements for a whole year.
6.2.9. Conservation and Rejuvenation:

Forests contain 100 per cent of water resources. Rivers fed by glaciers, groundwater and rainwater give rise to naulas, dharas (streams), gadheras (tributaries), khals and ponds, which primarily sustain the lives of people in the hills. Considering that water from these sources has decreased alarmingly in the last four years - by 75 per cent in some places - government has prioritised the identification, protection and rejuvenation or recharging of these traditional water resources in Himachal Pradesh and Uttarakhand. There is a move to recharge water in the Reserved Forests under the Forest Department by impounding water and making structures like contour furrows and dug wells, among others.

Further, linking water conservation programmes with income generating activities like cultivation of off-season vegetables, aromatic and medicinal plants, floriculture, fisheries etc., will ensure people's protection of their income sources, namely water.

A Catchment Area Treatment Plan, that includes keeping the forest alive, is required for every water resource in the watershed. The Draft Water Policy underscores the formulation of a policy and technology to initiate ground water recharge and water quality monitoring programmes. Appropriate irrigation techniques, for optimising water use across a large section of users, are necessary.

6.3. Soil Resource Depletion:

Generally environmental degradation in the Yamuna valley of Garhwal Himalaya has been recorded in the form of soil erosion, landsliding, soil slips, soil creeping, mass wasting, severe infiltration, fast intensive and extensive run-off, block disintegration and gullying, which occurs on account of ecological imbalances caused by deforestation, overlopping, overgrazing, unscientific overblasting for quarrying, road, dam and canal construction, over-fallowing and over-ploughing. (These factors have been already discussed with in Chapter –V under Landslides- Causes and Location). Environmental degradation occurs when the ecological balance of a particular ecosystem is degraded. Ecological balance of a particular ecosystem is the normal
difference (variability between the soil moisture and air moisture of a particular temperature at particular time and space.

The increasing pressure on the land disturbs the natural balance between soil formation and soil conservation on the one hand and soil erosion on the other hand. It is the function of soil and water conservation measures to restore and maintain this balance (Anantharaman et al., 1984). Yamuna valley is constantly subjected to severe soil erosion due to deforestation, quarrying, floods, excessive run-off, landsliding, leaching and soil creeping and these lead to the depletion of soil, water, forest, mineral and climatic resources.

Maximum soil erosion occurs when giant star grass is grown on bare land, but on cultivated land, the contour cultivation systems with maize and wheat crop combination results in minimum loss (Tripathi, 1968). It may, therefore, be concluded that the land need not be left bare fallow.

Fig 6.2: Environmental degradation due to Soil erosion and landsliding near Nawagaon.
6.3.1. Soil erosion and deforestation:
The practice of deforestation prevails in the forest villages of the valley. Towards Lesser Himalayan slopes deforestation also occurs on account of fast flow huge amount of rain water which washes the decomposed layer of silts, pebbles and weakens the rock due to which trees fall down. The Yamuna valley forest ranges are also mostly depleted by people for fuel and cultivation in the haphazard manner.

6.3.2. Soil erosion due to over-grazing:
Overgrazing is one of the constant factor responsible for the causation of soil erosion in the valley. The cultivated land adjacent to the forest roads is generally decomposed by the movement of animals and this decomposed layer of soil is badly washed out during the monsoon months.

Fig. 6.3: Soil erosion due to toe erosion of terrace by Yamuna river and Naugaon town is also visible in the middle of the photograph.
6.4. Soil resource conservation:
The devices against soil erosion should mainly be directed to the removal of its causes and not to its consequences. The measures against soil erosion should be based on a harmonious complex comprising forest reclamation, agrotechnical and hydrotechnical measures within the framework of the scientific management of the land. This complex and system of measures should be on the fight against stream erosion, involving the immediate protection of the soils of the whole catchment basins through the creation of belts and grazing strips and the control of cultural microrelief as well as through the undertaking of engineering works i.e. ditches, embankment terraces, dikes, dams, drainage and water absorbing installations so as to redisturb the surface run-off and eliminate the ablation of the soil (Saxena and Saxena, 1981).

The soil conservation measures are classified into two parts viz. biotic measures and mechanical measures. The biotic measures check the soil erosion indirectly and the mechanical measures check the soil erosion directly.

(A) Biotic measures:

(1) Nature of crop cover:
Cultivated legumes in general provide better cover hence better protection to cultivated land against the erosion than the cultivated bare fallow land.

(2) Intensity of ploughing:
It has been observed that too many unnecessary tilting operations are harmful to land and accelerates soil erosion due to run-off. Further they reduce production also. Three ploughing are sufficient for maximum yield of maize grains and peas grains in the valley.

(3) Change in crop rotation:
Of most importance with regards to the fight against soil erosion is the choice of correct rotation of crops, taking into account the time which the soil is protected from erosion by agricultural crop. Good crop rotation under maize-peas and maize-wheat rotation can yield higher return and effectively check soil erosion in the valley.
(4) Afforestation:  
Protective forestation in the valley constitute one of the most important measures for guarding soils against the harmful effects of droughts, ablation and scouring. Therefore, one should resort to afforestation wherever the soil is in need of such protection (Allen, 1957). Forest belts combined with grass and soft fruit strips on terraces and other water retaining measures should be adopted.

Vegetative measures include planting of quick growing species of trees (Acacia catechu, Cedrella toona, Leucaena leucocephela, Lannea gradis, salix etc. Geojute technique can be used to stabilize the highly degraded gravelly areas (Juyal et al., 1995).

Only those species should be planted which are native to the place which also fulfill the day to day requirements of the people. Broad leaved fodder trees, nutritive grasses and leguminous fodder species should also be included under the plantation programme (Singh and Saxena, 1988).

People in the area under study maintain live stocks for milking, meat, farming and transportation. Therefore the recommendation for the introduction of selected species of grasses in the slide prone areas will serve double purpose i.e. checking of soil erosion and development of pasture land. Lavosier, (1958) emphasized growing of grasses for improving soil fertility of the land. In this connection Om Prakash, Pant and Rawat, (1978) carried out experiment with thirty important grasses for their nutritive value and protective influence of soil.

Under tropical and temperate conditions the increase in crop yield when growing is followed by grass has been reported by Belonozko, (1943) and Mandal, (1955). Study of influence on various grasses on the soil fertility of Kumaon hills, reveal the role of nine important grasses on total carbon, nitrogen, available P₂O₅, CaO content and pH status of soil after transplantation of these grasses (Om Prakash, Pant and Rawat, 1975). Based on the studies, Pant and Joshi (1994) have recommended following grasses for stabilizing the soil as well as supplementing the nutritive value of fodder for grazing are as following:  
*Giant star*, *Kikiyu* (*Pennisutum clandestinim, P. flaccidum, P. orientale*), *Perennial rye*
Fescue, Brome, Bahia, Weeping love, Crested wheat, Hybrid napier, Cynodon dactylon, Cynodon plectostachyus, and Apluda mutica.

The kikiyu grasses have been found best to cover the areas prone to landslides as these grasses are fast spreading and make a good volume of vegetative cover on the soil and survive well up to 2600m altitude. They may be transplanted on a large scale from first week of June to last week November in the slide prone areas. Along road sides the plantation of the hybrid Napier grass, Poplar trees and Mexican pines are helpful in the stabilizing soil affected by landslides. The Mexican pine is very fast growing species and cover barren area in a short time. The plantation is done in rainy season. Incorporation of Pencium repens, Brachia mutica, Cynodon dactylon, Cynodon plectostachyus, Paspal notatum, Trifolium impulina and Trifolium partense seeds along with kikiyu grasses transplantation will be much helpful for providing better vegetative cover on soil.

(B) Mechanical measures:

Mechanical measures play very important role in soil erosion control. The mechanical measures include graded bunding or channel terraces, contour cultivation, contour strip farming, bench terracing and buffer strip cropping.

(1) Channel terraces
They reduce soil loss by decreasing the length of the slope. This method should be used in areas having annual rainfall more than 200cm. In this method a portion of water is allowed to be impounded to infiltrate the soil and divert some water on one side of the field (Khan, 1960). This method should be applied in the lower terraces of Yamuna valley.

(2) Contour cultivation
Each ridge of the contour furrow formed by contour farming serves as a dam and each depression as a diversion ditch. The water is allowed to enter the soil body and to percolate through it, rather than run-off the surface and carry away the fertile cover of the soil.
(3) Contour strip cropping
In this method beds of crops are grown on the contour at right angles to the natural slopes of the land. This is also effective to control soil erosion.

(4) Bench terracing
It is one of the most important mechanical soil conservation practices. Bench terracing is constructed by half cutting and half filling and the original ground slope is converted into level step like folds. This practice is suggested in villages located along the water divide and spurs.

(5) Buffer strip cropping
In this method, on steep badly eroded areas of the slope, strip grass or legume crops are laid out between strips of crops in regular rotation.

Fig 6.4: Soil resource conservation by making small retaining walls along the Yamuna river bank to avoid soil erosion by the river.