2.1 IRRIGATION DEVELOPMENT AND WATERSHEDS

Irrigation:

- Irrigation is the application of controlled amounts of water to plants at needed intervals.
- Irrigation helps to grow agricultural crops, maintain landscapes, and revegetate disturbed soils in dry areas and during periods of less than average rainfall.
- Irrigation also has other uses in crop production, including frost protection, suppressing weed growth in grain fields and preventing soil consolidation.
- In contrast, agriculture that relies only on direct rainfall is referred to as rain-fed or dry land farming.
- Irrigation systems are also used for cooling livestock, dust suppression, disposal of sewage, and in mining. Irrigation is often studied together with drainage, which is the removal of surface and sub-surface water from a given area.

Types of irrigation:

There are several methods of irrigation. They vary in how the water is supplied to the plants. The goal is to apply the water to the plants as uniformly as possible, so that each plant has the amount of water it needs, neither too much nor too little.

1. Surface irrigation:

Surface irrigation is the oldest form of irrigation and has been in use for thousands of years. In surface (flood, or level basin) irrigation systems, water moves across the surface of an agricultural lands, in order to wet it and infiltrate into the soil. Surface irrigation can be subdivided into furrow, border strip or basin irrigation. It is often called flood irrigation when the irrigation results in flooding or near flooding of the cultivated land. Historically, this has been the most common method of irrigating agricultural land and is still used in most parts of the world.

2. Micro-irrigation:

Micro-irrigation, sometimes called localized irrigation, low volume irrigation, or trickle irrigation is a system where water is distributed under low pressure through a piped network, in a predetermined pattern, and applied as a small discharge to each plant or adjacent to it. Traditional drip irrigation using individual emitters, subsurface drip irrigation (SDI), micro-spray or micro-sprinkler irrigation, and mini-bubbler irrigation all belong to this category of irrigation methods.

3. Drip irrigation:

Drip irrigation, also known as trickle irrigation, functions as its name suggests. In this system waterfalls drop by drop just at the position of roots. Water is delivered at or near the root zone of plants, drop by drop. This method can be the most water-efficient method of irrigation, if managed properly, evaporation and runoff are minimized.

4. Sprinkler irrigation:

In sprinkler or overhead irrigation, water is piped to one or more central locations within the field and distributed by overhead high-pressure sprinklers or guns. A system using sprinklers, sprays, or guns mounted overhead on permanently installed risers is often referred to as a solid-set irrigation system. Higher pressure sprinklers that rotate are called rotors and are driven by a ball drive, gear drive, or impact mechanism. Rotors can be designed to rotate in a full or partial circle Guns are used not only for irrigation, but also for industrial applications such as dust suppression and logging. Sprinklers can also be mounted on moving platforms connected to the water source by a hose. Automatically moving wheeled systems known as traveling sprinklers may irrigate areas such as small farms, sports fields, parks, pastures.

5. Center pivot:

Center pivot irrigation is a form of sprinkler irrigation utilizing several segments of pipe (usually galvanized steel or aluminum) joined together and supported by trusses, mounted on wheeled towers with sprinklers positioned along its length. The system moves in a circular pattern and is fed with water from the pivot point at the center of the arc.

6. Lawn sprinkler systems:

A lawn sprinkler system is permanently installed, as opposed to a hose-end sprinkler, which is portable. Sprinkler systems are installed in residential lawns, in commercial landscapes, for churches and schools, in public parks. Although manual systems are still used, most lawn sprinkler systems may be operated automatically using an irrigation controller, sometimes called a clock or timer. Most automatic systems employ electric solenoid valves. Each zone has one or more of these valves that are wired to the controller. When the controller sends power to the valve, the valve opens, allowing water to flow to the sprinklers in that zone.

There are two main types of sprinklers used in lawn irrigation,

(a) Pop-up spray heads

(b) Rotors.

Spray heads have a fixed spray pattern, while rotors have one or more streams that rotate. Spray heads are used to cover smaller areas, while rotors are used for larger areas. Golf course rotors are sometimes so large that a single sprinkler is combined with a valve and called a 'valve in head'. When used in a turf area, the sprinklers are installed with the top of the head flush with the ground surface. When the system is pressurized, the head will pop up out of the ground and water the desired area until the valve closes and shuts off that zone. Once there is no more pressure in the lateral line, the sprinkler head will retract back into the ground. In flower beds or shrub areas, sprinklers may be mounted on above ground risers or even taller pop-up sprinklers may be used and installed flush as in a lawn area.

7. Hose-end sprinklers:

There are many types of hose-end sprinklers. Many of them are smaller versions of larger agricultural and landscape sprinklers, sized to work with a typical garden hose. Some have a spiked base allowing them to be temporarily stuck in the ground, while others have a sled base designed to be dragged while attached to the hose.

8. Sub irrigation:

Sub irrigation has been used for many years in field crops in areas with high water tables. It is a method of artificially raising the water table to allow the soil to be moistened from below the plants' root zone. Often those systems are located on permanent grasslands in lowlands or river valleys and combined with drainage infrastructure. A system of pumping stations, canals, weirs and gates allows it to increase or decrease the water level in a network of ditches and thereby control the water table. Sub irrigation is also used in the commercial greenhouse production, usually for potted plants. Water is delivered from below, absorbed by upwards, and the excess collected for recycling. Typically, a solution of water and nutrients floods a container or flows through a trough for a short period of time, 10–20 minutes, and is then pumped back into a holding tank for reuse. Sub-irrigation in greenhouses requires fairly sophisticated, expensive equipment and management. Advantages are water and nutrient conservation, and labor savings through reduced system maintenance and automation. It is similar in principle and action to subsurface basin irrigation. Another type of sub irrigation is the self watering container, also known as a sub irrigated planter. This consists of a planter suspended over a reservoir with some type of wicking material such as a polyester rope. The water is drawn up the wick through capillary action. A similar technique is the wicking bed; this too uses capillary action.

9. Subsurface textile irrigation:

Subsurface Textile Irrigation (SSTI) is a technology designed specifically for sub irrigation in all soil textures from desert sands to heavy clays. A typical subsurface textile irrigation system has an impermeable base layer (usually polyethylene or polypropylene), a drip line running along that base, a layer of geo textile on top of the drip line and, finally, a narrow impermeable layer on top of the geo textile. Unlike standard drip irrigation, the spacing of emitters in the drip pipe is not critical as the geo textile moves the water along the fabric up to 2 m from the dripper. The impermeable layer effectively creates an artificial water table.

Environmental impacts of irrigation:

The environmental impacts of irrigation relate to the changes in quantity and quality of soil and water as a result of irrigation and the effects on natural and social conditions in river basins and downstream of an irrigation scheme. The impacts stem from the altered hydrological conditions caused by the installation and operation of the irrigation scheme.

It may have,

1. Direct effect

2. Indirect effect

1. Direct effects:

An irrigation scheme draws water from groundwater, rivers, lakes or overland flow, and distributes it over an area. Hydrological or direct effects of doing this include,

- Reduction in downstream river flow
- Increased evaporation in the irrigated area
- Increased level in the water table as groundwater recharge in the area is increased and flow increased in the irrigated area.
- Likewise, irrigation has immediate effects on the provision of moisture to the atmosphere.
- Atmospheric instabilities and increasing downwind rainfall
- Modifies the atmospheric circulation.
- Delivering rain to different downwind areas.

2. Indirect Effects:

Indirect effects are those that have consequences that take longer to develop and may also be longer-lasting. The indirect effects of irrigation include the following:

- Water logging
- Soil salination
- Ecological damage
- Socioeconomic impacts

The indirect effects of water logging and soil salination occur directly on the land being irrigated. The ecological and socioeconomic consequences take longer to happen but can be more far-reaching.

Some irrigation schemes use water wells for irrigation. As a result, the overall water level decreases. This may cause,

- Water mining
- Land/soil subsidence
- Salt water intrusion.

Adverse impacts:

1. Reduced river flow:

The reduced downstream river flow may cause:

- Reduced downstream flooding.
- Disappearance of ecologically and economically important wetlands or flood forests.
- Reduced availability of industrial, municipal, household, and drinking water.
- Reduced shipping routes.
- Reduced fishing opportunities.

2. Increased groundwater recharge, water logging, soil salinity

This may cause the following issues:

- Rising water tables
- Increased storage of groundwater that may be used for irrigation, municipal, household and drinking water by pumping from wells .
- Water logging and drainage problems in villages, agricultural lands, and along roads - with mostly negative consequences. The increased level of the water table can lead to reduced agricultural production.
- Shallow water tables - a sign that the aquifer is unable to cope with the groundwater recharge stemming from the deep percolation losses.
- Stagnant water tables at the soil surface are known to increase the incidence of water-borne diseases like malaria, yellow fever,and dengue in many areas. Health costs, appraisals of health impacts and mitigation measures are rarely part of irrigation projects, if at all.
- To mitigate the adverse effects of shallow water tables and soil salinization, some form of water table control, soil salinity control, drainage and drainage system is needed.
- As drainage water moves through the soil profile it may dissolve nutrients (either fertilizer-based or naturally occurring) such as nitrates, leading to a buildup of those nutrients in the ground-water aquifer.
- High nitrate levels in drinking water can be harmful to humans, particularly infants under 6 months, where it is linked to "blue-baby syndrome".

3. Reduced downstream river water quality:

Owing to drainage of surface and groundwater in the project area, which waters may be salinized and polluted by agricultural chemicals like biocides and fertilizers, the quality of the river water below the project area can deteriorate which makes,

- It less fit for industrial, municipal and household use.
- It may lead to reduced public health.
- Polluted river water entering the sea may adversely affect the ecology along the sea shore.

4. Affected downstream water users:

Downstream water users often have no legal water rights and may fall victim of the development of irrigation. Flood-recession cropping may be seriously affected by the upstream interception of river water for irrigation purposes.

In Baluchistan, Pakistan, the development of new small-scale irrigation projects depleted the water resources of nomadic tribes traveling annually between Baluchistan and Gujarat or Rajasthan, India.

After the closure of the Kainji dam, Nigeria, 50 to 70 per cent of the downstream area of flood-recession cropping was lost

5. Lost land use opportunities:

Irrigation projects may reduce,

- The fishing opportunities of the original population and
- The grazing opportunities for cattle.
- The livestock pressure on the remaining lands may increase considerably, because the ousted traditional pastoralist tribes will have to find their subsistence and existence elsewhere, overgrazing may increase, followed by serious soil erosion and the loss of natural resources.

6. Groundwater mining with wells, land subsidence:

When more groundwater is pumped from wells than replenished, storage of water in the aquifer is being mined and the use of that water is no longer sustainable. As levels fail, it becomes more difficult to extract water and pumps will struggle to maintain the design flow rate and consume more energy per unit of water. Eventually it may become so difficult to extract groundwater that farmers may be forced to abandon irrigated agriculture.

Direct advantages of Irrigation:

Following 4 types of direct advantages of irrigation are described below:

(i) Increase in food production

Irrigation improves the yield of crops, which leads to an increase in food production, thus developing people as well as society.

(ii) Revenue generation

When a consistent supply of water is guaranteed for irrigation, the cultivators can grow certain predominant or expensive crops (like cash crops) instead of substandard or low priced crops. In this manner income is created.

(iii) Protection against drought

The provision of adequate irrigation facilities in any region ensures protection against failure of crops from famine or droughts.

(iv) Mixed cropping

Mean sowing of at least two types of crops together in a similar field. This practice is followed so that if climate conditions are not good for one crop it might be reasonable for other crops. But if irrigation facilities are made available, the need of mixed cropping is eliminated.

Indirect advantages of Irrigation

Following 4 types of indirect advantages of irrigation are described below:

(i) Power generation

Major river valleys projects are generally planned to generate hydroelectric power together with irrigation. However, comparatively a small quantity of hydroelectric power might also be generated at a small cost on projects which are primarily planned for irrigation.

(ii) Transportation

The irrigation canals are provided with unsurfaced roads primarily for purposes of inspection and maintenance. These roads give a decent pathway to nearby people. The network of irrigation canals can be used for transportation of goods as well as human beings.

(iii) Groundwater table

In areas where irrigation facilities are provided, due to constant percolation of a portion of the water flowing in the canals and also that is supplied to the field, the groundwater storage is increased and consequently, the groundwater table is raised.

(iv) Employment

During the constructions of irrigation works, employment is provided.

Disadvantages of Irrigation

- The enormous supply of irrigation water tempts the cultivators to use more water than required. Due to Excess water supplied to the field, which leads to percolating water into the soil. Hence, due to the constant percolation groundwater table would be raised and will prompt water logging.
- The ground water can get polluted due to seepage of the nitrates (applied to the soil as fertilizers) into the groundwater.

WATERSHEDS:

- Watersheds are land areas that channel water to a particular location, such as a river, lake, ocean or other body of water.
- Watersheds vary in size, and each smaller watershed is part of a larger one. For example, a small stream has its own watershed and so does the river into which that stream feeds. The watershed that encompasses the Mississippi River is enormous, covering two-thirds of the North American continent.

- The flow from rain, snowmelt, and natural underground springs from the headwaters of area streams. As water moves downstream, it feeds into successively larger bodies of water, like rivers and lakes, eventually flowing out into the ocean.
- Because these drainage basins are part of an integrated network with no clear boundaries, they are especially vulnerable to changes in the balance of the ecosystem.
- A pollutant that enters at the headwaters not only can disturb the area at the point of entry, it can also affect each source of water into which the tributaries drain.
- However, watersheds are also valuable in that some parts, wetlands in particular, provide a buffer zone in which many nutrients and sediments are filtered. Given the importance of watershed management, especially with respect to water supply and quality, resources should be managed from the perspective of the watershed, in an integrated fashion, rather than focusing on resources in an immediate area.
- Watersheds directly affect water quality, whether it's for drinking or recreation. For example, algae blooms from fertilizer runoff draining into water harm watershed health, as do mercury and lead seeping into the water supply due to pollution. As states and cities try to find new sources of uncontaminated drinking water, keeping watersheds healthy becomes increasingly vital to finding clean water.
- Unhealthy watersheds affect wildlife, The polluted water supply that results can become harmful to humans. Aquatic life quickly suffers the effects of watershed pollution, while new pollutants introduced into ecosystems alter wildlife habitats. This reduces biodiversity by eliminating some species and introducing new, invasive ones that destroy the native species. That, in turn, can affect the food chain, from microbial organisms that feed birds and animals to fish that feed humans.

TYPES OF WATERSHED:

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

1. Macro watershed (> 50,000 Hect)
2. Sub-watershed (10,000 to 50,000 Hect)
3. Milli-watershed (1000 to10000 Hect)
4. Micro watershed (100 to 1000 Hect)
5. Mini watershed (1-100 Hect)

Factors influence watersheds:

Climate:

Climate is the major force shaping the land and controlling stream flow. The climate of an area is determined by the area's latitude, elevation, vegetation, topography and nearness to the oceans or other large water bodies. Together these factors determine temperatures, humidity, wind, precipitation and evaporation in a watershed. Weathering factors, such as rain, snow, wind, glaciers and temperature changes, erode soil and rock formations and change the topography of the watershed. Climate also affects stream flow, which creates and changes stream channels.

Geology:

The geology of a watershed is important because it influences topography, direction of water flow, shape of the drainage basin, stream bed materials, water quality and biological productivity. Geologic forces cause the earth's surface to rise or fall and, along with weathering, determine the topography of the watershed.

Topography:

Topography is the shape and physical features of land. The topography of a stream channel and its watershed reflects the geology of the watershed. In turn, watershed topography helps produce the pattern and distribution of stream channels. Topography of a watershed also determines the steepness of the land surface and stream channels. We also know this steepness as slope, grade or gradient. The height and steepness of the hills, floodplains and channels contribute to the erosive power of the water in a watershed and its stream channels. Steep slopes allow the force of gravity to quickly accelerate the speed of flowing water. The faster water flows the more energy or power it has to erode and move soil, sand, gravel, boulders and debris. Topography also affects sinuosity of streams.

Hydrology:

Hydrology is the science that deals with the properties, distribution and circulation of water in the atmosphere, on the land and underground. Short-term and long term climatic conditions affect how much precipitation is available to shape and develop the features of a watershed. The amount, type and timing of precipitation directly affect erosion and deposition in a watershed. Hydrology of a watershed is greatly affected by how much precipitation and temperature vary over time.

Soils:

Soil is unconsolidated (loose) mineral matter on the surface of the earth. Soil can support plants because physical, chemical and biological processes have changed it. In turn, plants and their roots influence the soil. Soils directly affect the kinds of vegetation that can grow along a stream, on floodplains and in the watershed.

Watershed Shape:

Watersheds have many different shapes. Like watershed size, watershed shape affects how quickly precipitation and sediment are delivered to the mouth of the main stem.

Vegetation and Land Use:

The more vegetation there is in a watershed to intercept and transpire water, the less runoff there will be. The amount and type of vegetation in a watershed influence the rates of runoff and erosion in that watershed. Plants reduce the impact of raindrops on soil and slow the speed of water flowing across the surface of the land, allowing more water to infiltrate into the soil. A forested or native grass watershed typically delivers its runoff slowly so soil and channel erosion are usually not severe.

Drainage Network Patterns:

Drainage patterns, along with the shape of the watershed, will affect the timing and delivery of floodwaters and sediment to each part of the network.

WATERSHED MANAGEMENT:

Watershed is defined as a geo-hydrological unit draining to a common point by a system of drains. All lands on earth are part of one watershed or other. Watershed is thus the land and water area, which contributes runoff to a common point.

A watershed is an area of land and water bounded by a drainage divide within which the surface runoff collects and flows out of the watershed through a single outlet into a larger river (or) lake.

Objectives of watershed management programmes:

1. To control damaging runoff and degradation and thereby conservation of soil and water.
2. To manage and utilize the runoff water for useful purpose.
3. To protect, conserve and improve the land of watershed for more efficient and Sustained production.
4. To protect and enhance the water resource originating in the watershed.
5. To check soil erosion and to reduce the effect of sediment yield on the watershed.
6. To rehabilitate the deteriorating lands.
7. To moderate the floods peaks at downstream areas.
8. To increase infiltration of rainwater.
9. To improve and increase the production of timbers, fodder and wild life resource.
10. To enhance the ground water recharge, wherever applicable.

Factors affecting watershed management

a) Watershed characters

i) Size and shape

ii) Topography

iii) Soils

iv) Relief

b) Climatic characteristic

i) Precipitation

ii) Amount and intensity of rainfall

c) Watershed operation

d) Land use pattern

i) Vegetative cover

ii) Density

e) Social status of inability

f) Water resource and their capabilities.

Watershed Development:

Watershed development refers to the conservation regeneration and the judicious use of all the resources natural (like land, water plants, animals) and human within the watershed area. Watershed Management tries to bring about the best possible balance in the environment between natural resources on the one side and man and animals on the other. Since it is the man which is primarily responsible for degradation of environment, regeneration and conservation can only be possible by promoting awakening and participation among the people who inhabit the watersheds

WATERSHED DEVELOPMENT:

Man and his environment are interdependent. The changes in the environment directly affect the lives of the people depending on it. A degraded environment means a degraded quality of life of the people. Environmental degradation can be tackled effectively through the holistic development of the watershed. A watershed provides a natural geo-hydrological unit for planning any developmental initiative.

WATERSHED DEVELOPMENT PROGRAMME

Watershed is a geo-hydrological unit of an area draining to a common outlet point. It is recognized as an ideal unit for planning & development of land water and vegetation resources. According to 1999-2000 statistics a net sown area of 141.23 million hectare is under cultivation, out of which 84.58 million hectare is rain fed area.

Watershed Development as a means for increasing agricultural production in rain fed, semi-arid areas. There are nearly 85 million hectares of land as rain fed area in the country. These areas were bypassed by the Green Revolution and so experienced little or no growth in agricultural production for several decades. By capturing the Water Resources Management and improving the management of soil and vegetation, Watershed Development aims to create conditions conducive to higher agricultural productivity while conserving natural resources.

Objectives:

- To mitigate the adverse effects of drought on crops and livestock.
- To control desertification.
- To encourage restoration of ecological balance and
- To promote economic development of village community.

Six major projects / programmes in watershed development programme :

1. National Watershed Development Project for Rain fed Areas (NWDPRA)
2. Watershed Development in Shifting Cultivation Areas (WDSCA)
3. Drought Prone Areas Programme (DPAP)
4. Desert Development Programme (DDP)
5. Integrated Wasteland Development Project (IWDP)
6. Employment Assurance Scheme (EAS)

These six projects / programmes also account for about 70 percent of funds and area under watershed programmes in the country.