2.3 EROSION AND PROBLEMS OF DEPOSITION IN IRRIGATION SYSTEMS

Erosion:

In earth science, erosion is the action of surface processes (such as water flow or wind) that removes soil, rock, or dissolved material from one location on the Earth's crust, and then transports it to another location. This natural process is caused by the dynamic activity of erosive agents, that is, water, ice (glaciers), snow, air (wind), plants, animals, and humans.

Physical processes:

1. Rainfall and surface runoff:

Rainfall, and the surface runoff which may result from rainfall, produces four main types of soil erosion:

- Splash erosion
- Sheet erosion
- Rill erosion, and
- Gully erosion.

2. Rivers and streams

Valley or stream erosion occurs with continued water flow along a linear feature. The erosion is both downward, deepening the valley, and head ward, extending the valley into the hillside, creating head cuts and steep banks.

3. Coastal erosion

Shoreline erosion, which occurs on both exposed and sheltered coasts, primarily occurs through the action of currents and waves.

4. Chemical erosion

Chemical erosion is the loss of matter in a landscape in the form of solutes.

5. Glaciers

Glaciers erode predominantly by three different processes: abrasion/scouring, plucking, and ice thrusting.

6. Floods

Erosion Occur by large volumes of rapidly rushing water.

7. Wind erosion

Wind erosion is a major geomorphologic force, especially in arid and semi-arid regions.

8. Mass movement

Mass movement is the downward and outward movement of rock and sediments on a sloped surface, mainly due to the force of gravity

Factors affecting erosion Rates:

- **Climate**

The amount and intensity of precipitation is the main climatic factor governing soil erosion by water. The relationship is particularly strong if heavy rainfall occurs at times when, or in locations where, the soil's surface is not well protected vegetation

- **Vegetative cover**

The removal of vegetation increases the rate of surface erosion.

- **Topography**

The topography of the land determines the velocity at which surface runoff will flow, which in turn determines the erosive of the runoff. Longer, steeper slopes (especially those without adequate vegetative cover) are more susceptible to very high rates of erosion during heavy rains than shorter, less steep slopes.

Soil Erosion Problems in Irrigation System:

- The factors affecting soil erosion from irrigation are the same as
  - Rainfall
  - water detaches
  - Transports sediment.
- However, there are some unique differences in how the factors occur during irrigation and in our ability to manage the application of water that causes the erosion. All surface irrigation entails water flowing over soil.
- Soil type, field slope, and flow rate all affect surface irrigation erosion, with flow rate being the main factor that can be managed.

- Ideally, sprinkler irrigation will have no runoff, but application rates on moving irrigation systems can exceed the soil infiltration rate, resulting in runoff and erosion.
- Using tillage practices to increase soil surface storage and selecting sprinklers with lower application rates will reduce sprinkler-irrigation runoff. Irrigation can be managed to minimize erosion and maintain productivity.

For example, rainfall occurs relatively uniformly over an entire field, whereas irrigation is seldom applied to an entire field at the same time. Irrigation is a controlled procedure where water is applied to a specific field, or portion of a field, at a specific time. This can affect the hydrology of the erosion processes on surface- and sprinkler-irrigated fields. A center pivot, for example, is essentially a moving storm that covers only 1–2% of the field at any given time.

- This results in unique runoff conditions where water can do the following:
  - Flow parallel to the lateral under similar conditions as rainfall
  - Flow from wet soil onto dry soil if the lateral is moving downhill; or
  - Flow onto wet soil if the lateral is moving uphill.
- In surface irrigation, water flow rate decreases with distance during surface irrigation as water infiltrates. Furrow flow rates also increase with time as infiltration rate decreases .
- This creates a condition where sediment can be detached on the upper end of the field and deposited on the lower end.
- Erosion rates on the upper end of a field those were 6 to 20 times greater than the field-average erosion rates eroded furrows on the upper end of a field after one furrow irrigation.
- During rainfall, raindrops wet the soil surface and detach soil particles. As runoff begins, rills form in wet soil. In contrast, irrigation furrows are formed prior to irrigation, and water flows onto initially dry soil.
- Furrows with initially dry soil have greater soil erosion than furrows that were preset immediately before furrow irrigation.

- Irrigation water flowing in furrows is not exposed to falling raindrops that can increase sediment detachment and decrease deposition.
- The quality of irrigation water can vary dramatically among water sources, or even within an irrigation tract if drainage water is reused. Conversely, electrolyte concentration of rainfall is quite consistent.
- Electrolyte concentration in irrigation water affects erosion for both surface and sprinkler irrigation. Lower electrolyte concentrations in water cause greater dispersion of soil particles, which tends to reduce infiltration and increase soil loss.

How to Prevent Soil Erosion:

1. Crop Rotation:

Rotating in high-residue crops such as corn, hay, and small grain can reduce erosion as the layer of residue protects topsoil from being carried away by wind and water.

Figure 2.3.1 Crop Rotation

[Source:https://static.eos.com/wp-content/uploads/2020/07/crop_rotation_1200-580.jpg]

2. Conservation Tillage:

Conventional tillage produces a smooth surface that leaves soil vulnerable to erosion. Conservation tillage methods such as no-till planting, strip rotary tillage, chiseling, and disking leave more of the field surface covered with crop residue that protects the soil from eroding forces.

Figure 2.3.2 Conservation Tillage

[Source:https://mda.maryland.gov/resource_conservation/PublishingImages/ConservationTillage.jpg]

3. Contour Farming:

Planting in row patterns that run level around a hill instead of up and down the slope has been shown to reduce runoff and decrease the risk of water erosion.

4. Strip Farming:

In areas where a slope is particularly steep or there is no alternative method of preventing erosion, planting fields in long strips alternated in a crop rotation system (strip farming) has proven effective.

5. Terrace Farming:

Many farmers have successfully combated erosion by planting in flat areas created on hillsides in a step-like formation (terrace farming).

6. Grass Waterways:

By planting grass in areas of concentrated water flow, farmers can prevent much of the soil erosion that results from runoff, as the grass stabilizes the soil while still providing an outlet for drainage.

7. Diversion Structures:

Used often for gully control, diversion structures cause water to flow along a desired path and away from areas at high risk for erosion.

PROBLEMS OF DEPOSITION IN IRRIGATION SYSTEMS

- Deposition of sediment in the irrigation-drainage canal network is an undesirable, yet inevitable occurrence in the course of the use and operation of any canal network system.
- Apart from the sediment deposited in the bottom and consequently reducing the designed, basic purposes and the functional performance of the canal network as well as hydraulic works constructed on them, the physical, chemical and biological properties of these sediment deposits are becoming issues of more immediate concern.
- Nutrients contained in the sediments may adversely affect water quality and uses; intensify eutrophication and growth of vegetative cover in the canals, with no limitations regarding the disposal of dredged sediment in the surrounding areas, due to its favorable impact on soil properties and fertility.
- However, increased content of hazardous and toxic substances in the sediment, followed with further degradation of suspended solids due to accumulation of pollutants, raised concentration or synergic effects of the said substances, etc. can have serious impacts (toxic, pathogenic, carcinogenic, mutagenic, etc.) not only on the canal system but also on the environment in which dredging sediment is disposed and stored.
- Suspended sediment in water bodies may contain, for the most part, necessary macro and micro nutrients, humus organic compounds and other ingredients improving properties of the soil onto which dredged sediment is to be deposited and spread.
- This refers particularly to the arable land, its texture and fertility, and consequently, to the yield and quality of the crops.
- Thus, reasons for the use of sediment on the land for agricultural purposes are more than obvious. It is clear that non-contaminated sediment may have positive impact on the land, and one of the basic principles calls for the incorporation of sediment in the land whenever possible. On the other hand, however, sediment

may contain heavy loads of nutrients and other unwanted substances with harmful affects on the land, crops and public health.

- Great care and caution is, therefore, needed in handling and depositing sediment in the environment, as well as the introduction of restrictive measures in its application in agricultural sector, that is, in its spreading or injecting on the farmland.
- Fine sediments settle on the beds of the smaller canals in many run of river irrigation schemes.
- Sedimentation affects the operation of schemes by reducing discharge capacities and raising water levels, and sediment deposits have to be removed periodically to maintain irrigation supplies.
- In many schemes de-silting costs are excessive, and in some, sediment settles faster than it can be removed using the funds that are available for maintenance. This results in problems of undersupply, inequity, and an inevitable decline in the area that can be irrigated.
- Sediment control structures are used at intakes from rivers to exclude or extract sediments in the sand and gravel size range, which would otherwise settle in main canals.
- However, these structures have little effect on the very fine sands and silts that are transported through main canal systems, but settle in smaller distributaries canals.
- The options for controlling deposition of fine sediments are limited, but could include: Sediment exclusion by closing the canal, or by reducing canal flows, during periods in which high sediment concentrations are transported.