Subject: Irrigation Engineering Sem: 4th Section:**B**

Unit-12: Water Logging

Water Logging and Drainage and Ground Water Re-charge

- Definition of water logging – its causes and effects, detection, prevention and remedies
- Surface and sub-surface drains and their layout
- Concept and various techniques used for ground water re-charge

Note: Definition of water logging – its causes and effects, detection, prevention and remedies **(Covered in this Article)**

WATER LOGGING

It's that time of the year again. The rains are pouring and the water seems to be going nowhere. Indeed the land is all soaked up and water is just rising up! People are forced to abandon their homes, while in the farms, crops are sinking under the water and some are dying out. Recognizing the symptoms of a problem is one thing. But understanding the problem and why it occurs is the first step towards knowing how to solve it.

A land is said to be **water-logged** when the soil pores within the root zone of the plants get saturated, and the normal growth of the plant is adversely affected due to insufficient air circulation.

Water logging is a condition of land in which the soil profile is saturated with water either temporarily or permanently (figure 1). In waterlogged lands, the water table rises to an extent that the soil pores in the crop root zone are saturated resulting in restriction of the normal circulation of air. This causes a decline in the level of oxygen and increase in the level of carbon dioxide. Generally, the water table is located at or near the surface resulting in poorly drained soils, adversely affecting crop production. Areas with water table within 2 m below the ground surface are considered as prone to water logging and those with water table within 2-3 m are considered to be at risk. Water logging can reduce the agricultural and economic value of land causing yield reductions or at times, total crop failures. Water logging is also a drainage problem.

Figure 1(a) Temporary water logging after a heavy rainstorm

Figure 1(b) Permanent water logging resulting from ground water contribution (wetland)

Categories of Water Logging

Water logging in agricultural lands can be of various types categorized according to:

a) Causes:

(i) Natural, e.g. natural swamps and valley bottoms

(ii) Human-induced water logging, e.g. through agricultural and other activities

b) Permanence

(i) Temporary – whereby water logging lasts a few days to several months

(ii) Permanent water logging – which occurs throughout the year.

c) Source of water

(i) Rainfed - mostly source of excess water is direct rainfall

(ii) Irrigated agriculture – water logging caused by water supplied for irrigation

d) Located on

(i) Agricultural lands – including cultivated lands

(ii) Other utility lands e.g. built up areas, urban areas.

Causes of Water Logging

Water logging is a drainage problem that results of high water inflow caused by rain, runoff, interflow, rise in groundwater, over irrigation or flooding. Drainage problems can be caused by low water outflow due to low infiltration rate, low hydraulic conductivity, flat terrain, lack of outlet or restricted outlet in the soil. In irrigated agriculture, drainage should be part of the overall design and implementation to avoid problems of water logging. Water logging can be caused by natural conditions or human induced activities, as follows:

Natural Causes:

a) Topography of a watershed

The topography, its slope, shape and drainage pattern has an important bearing on the drainage of a watershed. Areas that lie in valley bottoms, depressions and other flat lowlands tend to become waterlogged naturally as surface flows concentrate in these lowlands, causing natural swamps.

b) Geology

Some areas have an impervious stratum below the top soil which obstructs the infiltration of rainfall. This creates a false water table or perched water table. Also, Areas with shallow soils, high water tables or a hard pan close to the ground surface are likely get waterlogged, particularly if subjected to high rainfall events.

c) The weather

Areas that receive heavy rainfall for prolonged duration can get waterlogged temporarily or permanently (Figure 2-a).

d) Soil Type

Heavy clay soils such as black cotton soils are prone to water logging, as they hold moisture for long periods. Also, soils prone to surface sealing cause temporary water logging.

e) Seepage Inflows

Seepage and interflow from other water bodies e.g. lakes, rivers and shallow aquifers can cause water logging of adjacent lands. Also, subsoil flows from upper regions to lower areas may result in water logging (Figure 2-b).

f) Inadequate surface drainage

When the surface drainage is not adequate, the heavy precipitation in the area is not drained off quickly and the rain water remains stagnant over the area for considerable time. This gives rise to heavy percolation and water-table rises in the area.

Figure 2 (a) Water logging after heavy rains on shallow water table **(b) Water logging due to seepage inflows from river valley**

Human-Induced Causes of Water Logging

Human induced causes of water logging in agricultural lands are usually associated with bad water management whether under irrigated or rainfed agriculture. For instance:

a) Irrigation

Irrigation, if not well planned, can cause drainage problems for the irrigated lands and adjacent ones. This is because irrigation adds extra water to the soil profile, over and above the naturally occurring rainfall. There are several ways in which irrigation can increase water logging. They include:

(i) **Over irrigation:** over irrigation and intensive irrigation result in water logging. The excess water from irrigation and without proper drainage contributes to rise in the water table.

(ii) **Seepage from canals:** Excessive seepage from unlined canal system and water courses result in the rise of water table leading into water logging

(iii) **Inadequate drainage:** in irrigated areas, water losses from canal system and water courses continuously contribute to water table (Figure 3-a).

(iv) **Poor irrigation management:** poor irrigation and cropping management by the cultivator

(v) **Obstruction of natural drainage:** interception of natural drainage by the construction of canals, roads, railways, water courses, etc.

(vi) **Land locked parches having no outlets:** Water logging develops due to absence of outlet to drain excess irrigation or rain water (Figure 3-b)

Figure 3(a) Harvesting rice in waterlogged conditions due to poor drainage

Figure 3(b) Water logging due to poor land levelling

Rainfed systems

(i) **Excessive rainfall:** Rain, apart from irrigation, is the major cause of water logging when it is in excess and in the absence of adequate drainage (Figure 4-a).

(ii) **Flat topography:** Flat terrain with depressions lead to water logging as disposal of excess water is delayed resulting in increased percolation into the soil (Figure 4-b).

(iii) **Occasional spills by floods:** Occasional flooding of the countryside and storm floods water not quickly drained off gives rise to water table.

(iv) **Closed/contour** water conservation structures – Construction of soil and water conservation structures on the contour can impound too much water causing water logging

Figure 4 (a) Water logging from excessive rainfall and diversion of runoff **(b) Water logging on wheat field after heavy rainfall due to flat terrain**

Effects of Water Logging

The various effects of water logging on land and crops are as follows:

1. Creation of Anaerobic Condition in the Crop Root-Zone:

When the aeration of the soil is satisfactory, bacteriological activities produce the required nitrates from the nitrogenous compounds present in the soil which helps the crop growth. Excessive moisture content creates anaerobic condition in the soil. The plant roots do not get the required nourishing food or nutrients. As a result crop growth is badly affected.

2. Growth of Water Loving Wild Plants:

When the soil is waterlogged water loving wild plant life grows abundantly. The growth of wild plants totally prevents the growth of useful crops.

3. Impossibility of Tillage Operations

Waterlogged fields cannot be tilled properly. The reason is that the soil contains excessive moisture content and it does not give proper tilth.

4. Accumulation of Harmful Salts:

The upward water movement brings the toxic salts in the crop root-zone. Excess accumulation of these salts may turn the soil alkaline. It may hamper the crop growth.

5. Lowering of Soil Temperature:

The presence of excessive moisture content lowers the temperature of the soil. In low temperature the bacteriological activities are retarded which affects the crop growth badly.

6. Reduction in Time of Maturity:

Untimely maturity of the crops is the characteristic of waterlogged lands. Due to this shortening of crop period the crop yield is reduced considerably.

7. Inhibiting activity of soil bacteria

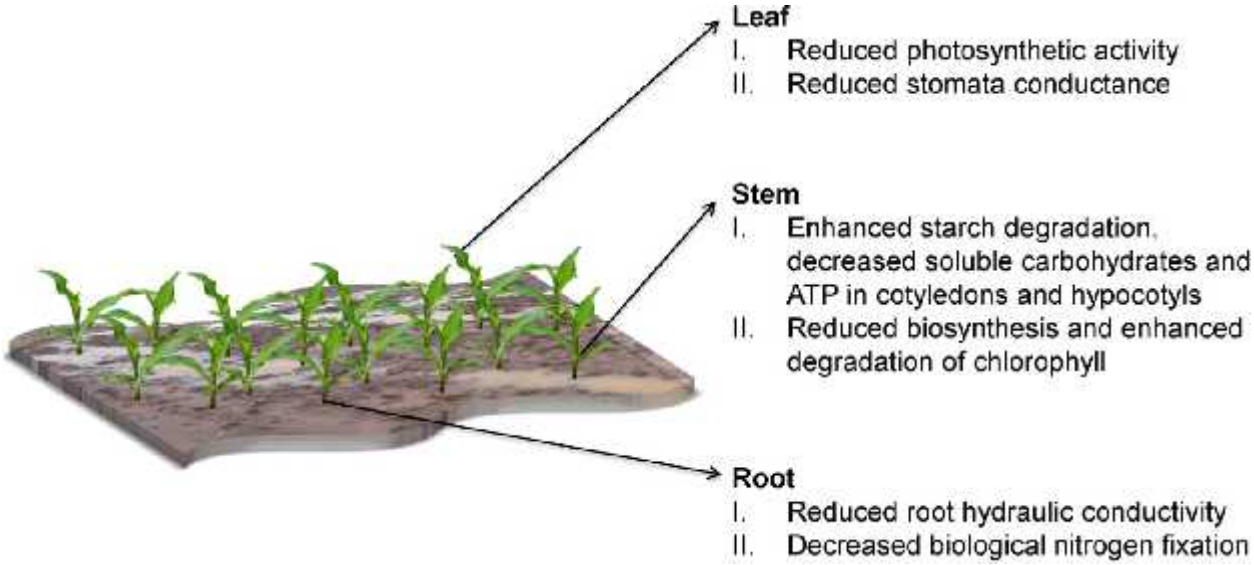
The liberation of plants food is dependents upon the activity of soil bacteria, which requires adequate amount of oxygen in the air for proper functioning. When the soil pores within the root zones of crops normally grown are so saturated as to effectively cut off the normal circulation of air, the land is said to be waterlogged.

8. Decrease in available capillary water

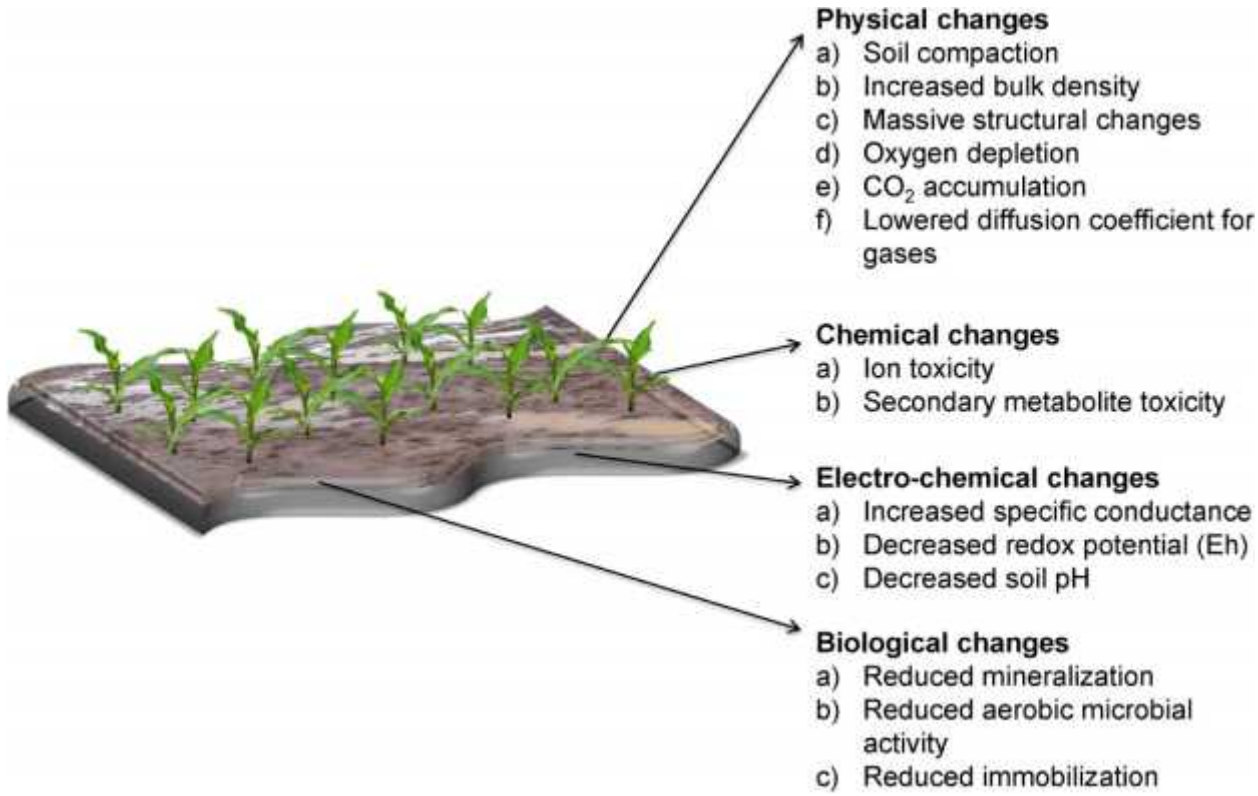
Plant life draws its substance from the soil-solution round the soil particles which is drawn into the plants by capillary action and osmosis. If the water table is high, the roots of the plants are confirmed to the top layers of the soil above the water table while if the water table is lower, the root of plants have more room for growth.

9. Defective air circulation

When the water-table is high, the drainage becomes impossible and the carbon dioxide liberated by plants root cannot be dissolved and taken away. Consequently fresh air containing oxygen is not drawn and activity of soil bacteria and plant growth suffers.



Effect of Water Logging on Plant Growth



Effect of Water Logging on Soil Properties

Detection of Water Logging

From the subject matter discussed above it is clear that the water logging is indicated when the ground water reservoir goes on building-up continuously. When the storage starts building up in the initial stages the crop growth is actually increased because more water is made available for the crop growth. But after some time the waters table rises very high and the land gets waterlogged. Finally the land is rendered unproductive and infertile.

- The problem of water logging develops in its full form slowly. Therefore its early detection is possible by keeping a close watch over the yields and also on the variations in the groundwater level. A comparative reduction in crop yields in spite of irrigation and fertilization and early maturity of crops indicate the symptoms of water logging.
- Also when harmful salts start appearing on the fields as white incrustation or deposit it indicates that water logging is likely to follow. In worst cases the water-table rises so high and close to the ground surface that the fields turn into swamps and marshes.

- The best way of keeping watch over the problem of water logging is by observing variations in the groundwater level. It can be done by measuring the depth of water levels at regular interval in the wells dug in the area. Continuous high water levels indicate that the groundwater storage is building up which may create water logging in the area.

Solution to the Problem of Water Logging

The problem of water logging may be attacked on two fronts.

- First is preventive measures, which keep the land free from water logging.
- Secondly curative measures may be adopted to reclaim the waterlogged area.

But in principle both measures aim at reducing the inflow and augmenting the outflow from the underground reservoir.

Preventive Measures:

Preventive measures include the following:

(a) Controlling the loss of water due to seepage from the canals:

The seepage loss may be reduced by adopting various measures for example

i. By lowering the FSL of the canal:

Loss may be due to percolation or absorption but when FSL is lowered the loss is reduced to sufficient extent. It is course essential to see that while lowering the FSL command is not sacrificed.

ii. By lining the canal section:

When the canal section is made fairly watertight by providing lining the seepage loss is reduced to quite a good extent.

iii. By introducing intercepting drains:

They are generally constructed parallel to the canal. They give exceptionally good results for the reach where the canal runs in high embankments.

(b) Preventing the loss of water due to percolation from field channels and fields:

The percolation loss can be removed by using water more economically. It may also be affected by keeping intensity of irrigation low. Then only small portion of the irrigable tract is flooded and consequently the percolation loss takes place only on the limited area. It keeps the water-table sufficiently low.

(c) Augmentation of outflow and prevention of inflow:

It may be accomplished by introducing artificial open and underground drainage grid. It may also be achieved by improving the flow conditions of existing natural drainages.

(d) Quick disposal of rainwater:

Quick removal of rainwater by surface or open drains is a very effective method of preventing the rise in water table and consequent water logging of the tract. It is needless to state that the rainwater removed is net reduction in inflow.

Curative Measures:

Curative measures include the following:

(a) Installation of lift irrigation systems:

When a lift irrigation project in the form of a tube well irrigation system is introduced in the waterlogged area the water table gets lowered sufficiently. It is found to be very successful method of reclaiming waterlogged land. Thus a combination of a canal system and a supplementary tube well irrigation system may be considered to be most successful and efficient irrigation scheme.

Of course it is true that it will create some complications while assessing the charges for irrigation water. (The canal water being cheaper than tube-well water). Implementation of drainage schemes: The waterlogged area may be reclaimed by introducing overland and underground drainage schemes.

(b) Implementation of Drainage Schemes:

The waterlogged area may be reclaimed by introducing overland and underground drainage schemes.