UNIT 2  WIND EROSION

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2.0 OBJECTIVES

After going through this unit, you should be able to:

- enumerate the causes and processes of wind erosion;
- explain the factors affecting wind erosion; and
- understand the procedure to measure soil loss through wind erosion.

2.1 INTRODUCTION

In the previous unit, causes and processes of erosion were explained. Various forms of water erosion, sediment transportation processes and soil loss due to water erosion were also amply dealt with.

Wind erosion is another eroding agent which causes severe soil erosion in a big way particularly in arid and semi-arid regions. The rainfall in these regions is very low (5 to 20 cm), soil is dry and vegetation is scanty. Wind is one of the most active agents of accelerated erosion. It occurs when winds blow across cultivated bare fields, especially if the soil is loose, dry and finely divided.
The soils along the rivers, lakes and coastal plains and the organic soils are removed by wind erosion. Wind erosion results in loss of soil fertility, formation of sand dunes and extension of deserts (Fig. 2.1). In addition, wind erosion causes high dust concentrations in atmosphere resulting in environmental health hazards. The effects of wind erosion in general are as significant as of erosion by water. Though wind erosion is predominant mainly in the arid and semi-arid regions, it occurs even in humid areas during the dry periods of the year and could be as serious as in arid and semi-arid regions.

![Fig. 2.1: Dunes developed by wind erosion](image)

### 2.2 CAUSES AND EFFECTS OF WIND EROSION

Wind erosion causes several damages. It not only removes the top fertile soil but also damages crops, buildings, highways, railways, fences etc. As the finer particles are easily transported, they are removed along with organic matter and nutrients. Finally, coarse textured sand particles are left which can be very easily detached. No vegetation grows on such soils and water holding capacity reduces. If the particles carried by wind strike the young seedlings, they get damaged. Maintenance of channels and railways becomes costly. Sometimes, the fertile land merges with desert and whole village or town may be affected due to ingress of desert, resulting from dry period and absence of a protective cover on the ground and broad, flat or undulating topography over which wind can move unchecked. The various impacts of wind erosion can be visualized as:

- Changes in soil texture resulting from attrition and winnowing
- Removal of top soil
- Scalding of the soil surface
- Exposure of root system of trees and shrubs
- Sand deposits
2.3 PROCESS OF WIND EROSION

Generally, the movement of soil by wind is a complex process. Soil blowing usually starts on exposed knolls or hilltops, tracks made by implements or animals and at the end of turn rows where excessive turning and cultivation have loosened the surface soil. Once soil starts moving from such sensitive points, the jumping soil grains severely serape the surface. The abrasion breaks down the soil aggregates, clods, stable crusts and wears down vegetative residues and living vegetative cover. The material detached from clods and crusts by abrasion may be either deposited on the leeward side of the field or carried away, depending upon the fineness of the soil and wind velocity.

2.3.1 Initiation and Movement

The initiation of movement of soil particles is caused by several factors acting separately or in combination. In the course of collision of soil grains rolling and bumping on the surface, some particles may be lifted up. Wind effects, such as an increase in the velocity, reduce the pressure resulting in a net upward thrust on the particles. Moving winds, which are turbulent in nature, impart vibration energy to initiate the movement of soil particles by dislodging. If the wind velocity is approximately greater than 3 km per hour, it creates turbulence, mainly of the eddy form. The wind velocity along with this turbulence initiates the soil movement process. The minimum velocity of wind required to initiate movement of a given size of soil particle is known as threshold velocity. The lowest threshold velocity of 13 to 14.5 km per hour at a height of 15 cm above the ground is required for particle of 0.1 to 0.15 mm diameter. The threshold velocity generally varies in the range of 21 to 48 km per hour at a height of 30 cm above smooth ground surfaces. However, once the particles start moving, velocity much lower than the static threshold velocity can maintain the soil movement. The minimum velocity required to continue soil movement under such a condition is called as dynamic threshold velocity.

2.3.2 Transportation

Once movement of soil particles is initiated, the transport of soil particles by wind takes place. The amount of soil particles moving from one place to another depends upon size of particle and its gradation, wind velocity and distance across the erodible area. Turbulent winds produce gusts with eddies and cross-currents that are responsible for lifting and transporting of the soil grains. The movement of the soil particles is of three distinct types depending upon the size of soil particles (Fig. 2.2).

Suspension

It occurs when very small soil particles become airborne and enter the main air stream. The movement of these particles is initiated by the impact of the medium size particles generally moving in saltation. They are carried in the same general direction as the wind. The soils made up of very fine particles especially with diameter less than 0.01 mm size remain in suspension and are lifted to great heights and carried to long distances away from the place of eroding area and are complete loss to the area. In contrast, soils moved in saltation and surface creep get deposited in the nearby area. Particles carried in suspension are deposited only when the wind velocity completely subsides or rainwater wets them.
Fig. 2.2: Movement of soil particles during wind

Saltation

The direct action of the wind on the soil particles and their collision with other particles creates soil movement known as saltation. It occurs when the wind lifts medium-sized soil particles into the air. Since they are too heavy to remain in suspension, they fall on to the ground surface thus loosening other soil particles and this process repeats itself. The particles are pushed along the ground surface due to the wind velocity in the initial stage. The movement continues for sometime and then descends almost in a straight line with an angle of descent of 6 to 12° with the horizontal. Thereafter, they strike the ground, may rebound and continue their movement by the saltation process. When the particles lose their energy by repeated striking, they may sink into the ground to form part of movement through surface creep.

Surface creep

It occurs along with saltation. The soil particles that are too heavy to be moved by saltation move along the surface by the impact of soil particles being displaced by saltation. Once the particles are lifted, their movement in suspension depends on the pattern of the wind movement. Particles in saltation receive their impact energy from the direct action of the wind pressure, whereas, in surface creep, the particles derive the kinetic energy from the impact of other particles moving in saltation. Major portion of the soil erosion by wind takes place in saltation. It may vary between 50 and 75% of the total weight of the soil eroded depending upon the relative size of the particles, wind velocity etc. Suspension may erode between 3 and 40 %, whereas the percentage of wind erosion by surface creep mainly depends upon the movement initiated by saltation. Therefore, if it is possible to prevent soil movement by saltation, the other two types get automatically controlled.

2.4 DEPOSITION

Deposition of the particles occurs when the gravitational force is greater than the forces holding the particles in the air. Deposition could occur when the wind velocity gets reduced due to surface obstructions or other natural causes. Wind can deposit sediment when its velocity decreases to a point where the particles can no longer be transported. This can happen when topographic barriers slow the wind velocity on the downwind side of the barrier. As the air moves over the top of the barrier, streamlines converge and the velocity...
Soil Erosion increases (Fig. 2.3). After passing over the barrier, the streamlines diverge and the velocity decreases. As the velocity decreases, some of the sediment in suspension can no longer be held in suspension and thus drops out to form a deposit. Topographic barriers can be such as rocks, vegetation and human made structures that project above the land surface. Actually, the process of lifting, transportation and deposition is continuous. Any obstruction that helps in reducing the wind velocity also helps to deposit the soil particles.

Vegetation and mechanical obstructions are helpful in reducing the wind velocity and thereby depositing the suspended particles and preventing them from being lifted up again. Most sediment is moved in the form of sand dunes. Sand dunes migrate through the transportation of sand up the gentle upwind side and deposition on the steeper slipface thereby recycling sand constantly (Fig. 2.4).

2.4.1 Formation of Sand Dunes

Sand dunes are formed in environments that favour the deposition of sand. Deposition occurs in areas where a pocket of slower moving air forms next to much faster moving air. Such pockets are typically formed behind obstacles like the leeward sides of slopes. As the fast air slides over the calm zone, saltating grains fall out of the air stream and accumulate on the ground surface. Dunes first begin their life as a stationary pile of sand that forms behind some type of vertical obstacle. However, when they reach a certain threshold size, continued growth may also be associated with active surface migration. In a migrating dune, grains of sand are transported by wind from the windward to the leeward side and begin accumulating just over the crest. When the upper leeward slope reaches an angle of about 30 to 34°, the accumulating pile becomes unstable and small avalanche begin to occur, moving sand to the lower part of the leeward slope. As a result of this process, the dune migrates over the ground as sand is eroded from one side and deposited on
the other resulting in the appearance of the dune to take on a wave shape. Active movement of sand particles across the dune causes windward slope to become shallow, while the leeward slope maintains a steep slope or slipface.

2.4.2 Types of Sand Dunes

Sand dunes are classified on the basis of shape, size and drifting forces of wind.

(i) Longitudinal dunes

They are formed when strong winds blow from at least two directions. The dune ridge is symmetrical, aligned parallel to the net direction of the wind and has slipfaces on either side (Fig. 2.5). The formation like sinuous wave is developed along longitudinal course of wind direction and it may be as long as 100 km and as high as 100 m. Longitudinal dunes develop under strong wind conditions and are confined to the southern and western part of the Thar desert in dry land areas.

(ii) Transverse dunes

Long asymmetrical dunes having a single long slipface are formed perpendicular to the wind direction as shown in Fig. 2.6. They develop when there is an abundant supply of sand and relatively weak winds. Transverse dunes generally predominate in the eastern and northern parts of the Thar Desert and develop under conditions where south-westerly winds are weak. The existence of big trees on the leeward side of the transverse dune is indicative of stabilization of the sand dune for a considerable time.
(iii) Crescent Dunes

In a crescent shaped dune, a long axis is formed transverse to the dominant prevailing wind direction (Fig. 2.7). The points of the dune are curved downwind and partially enclosing the slipface. It usually forms where there is a limited supply of sand, reasonably flat ground and a fairly even flow of wind from one direction. While sand dunes develop near the core, aeolian sand (wind deposited sand) and losses (deposited silt) are accumulated in the peripheral areas of the desert. Sand dunes in the south are higher rising sometimes to 150 m, whereas in the north they are lower and rise up to a height of 15 to 20 m in the Thar desert of India. The formation of sand dunes depends on three factors, viz. a prevailing moderate wind; plenty of sand and an obstacle like a rock or a tree that acts as the centre around which the sand may slowly collect. Sand dunes are highly deficient in organic matter and moisture and therefore, sustain only thin vegetation. The Thar Desert is largely man-made and is spreading gradually into new areas.

Fig. 2.7: Model indicating the wind direction and formation of sand dune (left side) and a panoramic view of crescent sand dunes (right side)

Check Your Progress 1

Note: a) Use the space below for your answers.

b) Compare your answers with those given at the end of unit.

1) Enumerate causes and effects of wind erosion.

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2) Explain the processes of wind erosion.

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3) Describe in brief the relationship between deposition and wind velocity.

4) What do you mean by sand dunes and how are they formed?

2.5 FACTORS AFFECTING WIND EROSION

Climate, soil and vegetation are the major factors affecting wind erosion at any particular location. Soil characteristics namely soil texture, structure, density of particles and organic matter content influence erosion by wind. Soil moisture content and surface roughness also have an important bearing on wind erosion. Soil moisture content is an important factor as relatively dry soil is subjected to wind erosion. Surface crusts when formed have a retarding influence on wind. Vegetation influences wind erosion directly when the area is under vegetation or indirectly by protecting the adjoining areas. Types of vegetation, its height, density and seasonal distribution are the main factors influencing wind erosion. Climate, soil condition, surface roughness and vegetative cover are the major factors affecting the amount of soil erosion by wind from a field as described below.

2.5.1 Climatic Conditions

Wind characteristics, precipitation, humidity and temperature are the main climatic factors influencing the soil moisture status resulting in soil susceptibility to erosion by wind under prevailing environment conditions. The velocity of the prevailing wind is the dominating factor affecting soil erosion in dryland areas. A minimum wind velocity termed as threshold velocity is required to dislodge the soil particles from a field. In general, wind erosion of soil only occurs when the soil surface is dry because surface tension holds the soil grains together when it is wet. Thus, higher soil moisture content increases the threshold velocity and decreases wind erosion up to the critical limit of soil moisture. As the soil moisture exceeds the critical limit, the wind erosion decreases sharply. In case of moisture content higher than 75% of field capacity of the soil, there is no effect of wind erosion. Thus, moist soil grains are virtually stable and in no danger of being eroded by the wind. Studies reveal that the wind is seldom strong enough to overcome the cohesive force of soil and water at about 15 bar tension (Table 2.1). The equivalent moisture is a ratio of the moisture content actually present in the soil to the water content at 15 bar tension (1 bar ≈ 1 atmosphere pressure = 10 m head of water).
### Table 2.1: Effect of Equivalent Moisture of Silt Loam Texture on Soil Erosion Under Different Wind Velocities at 15 cm Height (Chepil, 1956)

<table>
<thead>
<tr>
<th>No.</th>
<th>Equivalent moisture</th>
<th>Rate of soil erosion in mg/cm-width/sec under different velocities (km/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>32</td>
</tr>
<tr>
<td>1.</td>
<td>0.01</td>
<td>315</td>
</tr>
<tr>
<td>2.</td>
<td>0.25</td>
<td>295</td>
</tr>
<tr>
<td>3.</td>
<td>0.29</td>
<td>235</td>
</tr>
<tr>
<td>4.</td>
<td>0.34</td>
<td>230</td>
</tr>
<tr>
<td>5.</td>
<td>0.71</td>
<td>68</td>
</tr>
<tr>
<td>6.</td>
<td>1.03</td>
<td>2</td>
</tr>
</tbody>
</table>

### 2.5.2 Soils

Soil texture, structure, cohesiveness, bulk density, organic matter and size of erodible soil fractions are important factors influencing wind erosion. The most erodible particles are fine soil particles of 0.1 mm or less in diameter. Coarse textured soils of particle size 0.1 mm or less such as sandy loam, loamy sands and sands are most susceptible to wind erosion. Such soils are not able to bind the individual sand particles together due to deficiency of silt, clay and organic matter. These soils generally form a single grain structure which can be eroded easily by the deflation and abrasive energy of the wind. They form a week bond between the soil grains which get readily broken down and eroded by the wind. Loam, silt loam, clay loam and silty clay loam are relatively more resistant to erosion by wind. Similarly, soils with large aggregates and those with crusting behaviour are resistant to erosion. The resistance of the soil to both detachment and transportation is ascertained by the fraction size and bulk density of the erodible soil grains. The resistance of the different textures to the wind erosion can be determined by Terminal Fall Velocity (TFV) defined as the velocity at which a particle being transported by the wind is deposited on the ground surface (Fig. 2.8). The larger the soil particles, the greater is the wind speed required to keep it moving above the ground surface.

Fig. 2.8: Trend of falling velocities for different particle sizes for wind erosion
2.5.3 Surface Roughness

A rough ground surface is a low height barrier either formed through mechanical manipulation of the surface soil or by raising the obstructions coming through the ground surface. It reduces the abrasion and attrition, the normal build-up and concentration of eroding material downwind. Roughening the land surface is not always effective in reducing wind erosion, though it slows down wind velocity and tends to trap saltating soil particles. The effectiveness of surface roughness depends on the height and density of the vegetative cover and on the size, shape and lateral frequency of clods, ripples and ridges. Ridges and furrows made by mechanical methods are helpful to a large extent against soil erosion in dry areas. The erodible soil fractions move from the ridges to the subsequent furrows and are trapped in. The initial rate of soil blown over cultivated land is less when such a soil is left ridged rather than pulverized and smooth. It is due to the fact that the ridges reduce the wind velocity for some distance above the average surface of the land and trap soil particles on the leeward side of the ridges that is furrow. Generally, the optimum roughness for wind erosion is a height of 5 to 12.5 cm above the surface.

2.5.4 Vegetative Covers

Various kinds of vegetative covers such as crop stubble and residue and bio-mulching material efficiently protect the soil surface from eroding energies of wind by reducing the wind velocity at the ground surface. When the land is exposed directly to the wind in the absence of vegetative cover on the ground surface, it is exposed to erosion by the wind. Biomass and plant residues not only reduce wind velocity at the surface but also dissipate the erosive force exerted by the wind. Efficiency of such covers depends on the quality, quantity and orientation of the residue in relation to the prevailing wind direction. The finer and denser the residue, the more it slows the wind velocity and the more it reduces wind erosion.

Standing material and stubble are most effective in controlling wind erosion. In addition to reducing the wind velocity at the ground level, vegetative materials also trap drifting soil particles, thereby decreasing the impact of saltation on the soil surface. Surface vegetation, stubble and mulch are the most effective practical methods for permanent control of soil loss by the wind. Any practice which reduces vegetative cover to such an extent that protection is no longer ensured, should be avoided. Excessive tillage and clean cultivation along with over-grazing of pasture exposes the land to severe wind erosion and, as such, in dryland areas of arid eco-systems, stubble, residue, mulch farming and cover cropping may be followed frequently.

Check Your Progress 2

Note: a) Use the space below for your answers.

b) Compare your answers with those given at the end of unit.

1) Explain the factors responsible for wind erosion.
2) Surface roughness is an effective way to control wind erosion! Justify.

3) How does vegetation check the wind erosion and help in deposition?

2.6 MEASUREMENT OF WIND EROSION

The measurement of wind erosion is not as standardized as the methodologies developed for monitoring of water erosion in Indian conditions. In order to monitor the wind erosion hazards and their quantification, several types of sand traps are designed to characterize the various parameters and their effects. These equipments are of two types; first one is a fixed type set up at a particular point where continuous monitoring is carried out for long periods, while second one is portable type equipment installed temporarily for short term monitoring of wind erosion. Field sand trap and laboratory tunnel equipments used for general purpose of measurements are described below:

2.6.1 Field Sand Traps

Sand traps are designed to trap debris laden with wind moving in a unit width of band. Vertical and horizontal types of sand traps are commonly employed for monitoring the wind blown dust in the affected areas.

**Horizontal sand traps**

It consists of trough sets in the ground with their top level with the surface and kept parallel to the wind direction. The trap may sometimes be divided into several sections so that saltating soil grains fall into different compartments according to their bounce amplitude (Fig. 2.9).

![Horizontal sand trap diagram](image)

Fig. 2.9: Horizontal sand trap for measurement of eroded material carried by wind
Horizontal traps cause minimum interference with the wind but a considerable length is required to collect a representative sample. The sample comprises of a 25 cm collection tube which leads into a 75 cm vertical tube where the wind-blown material settles and falls on a tray mounted on the top of a balance. In this technique, the weight of the eroded material is recorded automatically. The top of the vertical tube is fixed into a wind vane with a ball bearing base which rotates the tubes so that the capture tube always faces the wind. The soil traps generally capable of collecting 90% saltating grains are placed at different heights to collect saltating soil grains throughout the wind profile.

**Vertical sand traps**

It consists of a series of boxes arranged one above the other so as to catch all the soil grains moving at different heights (Fig. 2.10). However, they cannot be easily reoriented to changing wind directions.

![Vertical sand trap for measurement of eroded material being carried by wind](image)

**2.6.2 Laboratory Wind Tunnels**

It is a standard method for measurement of eroded materials under various wind conditions. Wind tunnels are of two types, namely open-circuit type and closed-circuit type but the open circuit type tunnel is more popular for soil erosion measurement. In open circuit type tunnel, air is drawn in by the action of a fan from outside.

**Advantages of open-circuit type over closed-circuit type wind tunnels**

- Cheaper fabrication
- Easier operation.
- Easy control over the wind flow in the test section due to less upstream contact between the air and the boundary walls of the tunnel leading to less wind turbulence.
2.7 ESTIMATION OF SOIL EROSION BY WIND

A mathematical equation combining various factors influencing wind erosion is used to predict the amount of wind erosion likely to occur under a given set of field conditions. This equation is almost similar to the Universal Soil Loss Equation used for estimating water erosion. However, the estimation of constants in the wind equation is comparatively difficult.

The equation used for wind erosion is given as:

\[ \text{\( W_E = f(I \ K \ C \ L \ V) \)} \quad \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (1) \]

Where,

- \( W_E \) = average annual soil loss, tones/ha/yr;
- \( I \) = soil erodibility index is the potential for soil loss from a wide, level, unsheltered and isolated fields with a bare, smooth, loose and uncrusted surface. Soil erodibility is based on soil surface texture and calcium carbonate content;
- \( K \) = ridge roughness factor is a measure of the effect of ridges formed by tillage and planting implements. The ridge roughness is based on ridge spacing, height and erosive wind directions in relation to the ridge direction;
- \( C \) = climatic factor is a measure of the erosive potential of the wind speed and surface moisture at a given location;
- \( L \) = unsheltered distance is the distance across an erodible field, measured along the prevailing wind direction. This distance is measured beginning at a stable border on the upwind side and continuing downward to the non-erodible or stable area or to the downwind edge of the area being evaluated; and
- \( V \) = vegetative cover factor accounts for the kind, amount and orientation of growing plants or plant residue on the soil surface.

Check Your Progress 3

**Note:** a) Use the space below for your answers.

   b) Compare your answers with those given at the end of unit.


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2) State the formula for estimation of wind erosion.

2.8 LET US SUM UP

- Wind erosion is the result of movement of soil material by the wind. There are two main effects of wind erosion. Firstly, wind causes small particles to be lifted and, therefore, moving them to another region and secondly, these suspended particles may collide with larger particles causing further erosion.
- Wind erosion is a process of detachment, transportation and deposition of soil particles (sediment) which is the end product of soil erosion process.
- Wind erosion generally occurs in areas with little or no vegetation, often in areas where there is insufficient rainfall to support vegetation.
- Desertification occurs as a result of unfavourable climatic conditions, whereas nature of soil and scanty vegetation are the main causes of wind erosion.
- Vegetation gets destabilized due to loss of top fertile soil and with reduction in vegetative cover; the soil is more easily eroded.
- As the soil erodes and soil devoid of soil moisture, the area turns arid and the desert expands.
- Human impacts such as overgrazing, draining of land and lowering of the groundwater table can also contribute to desertification. Sand dunes are the visible indicators of the region.

2.9 KEYWORDS

Abraion : Bedrock surface or stone that has been reshaped by the friction of wind blown sediment.

1 bar : Equivalent to suction at 1 atmosphere which is equal to 10 m of water head.

Conservation : It is defined as the protection, improvement and use of natural resources in such a way so that maximum economic or social benefits are realized without deterioration of the resources.

Deflation : It is the lowering of the land surface due to removal of fine grained particles by the wind. Deflation concentrates the coarser grained particles at the surface, eventually resulting in a surface composed only of the coarser grained fragments that cannot be transported by the wind. Such a surface is called desert pavement.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detritions</td>
<td>The process of wearing something away by friction.</td>
</tr>
<tr>
<td>Erodibility</td>
<td>It is vulnerability or susceptibility of the soil to erosion. It depends primarily on the physio-chemical characteristics of the soil.</td>
</tr>
<tr>
<td>Erosion</td>
<td>The detachment, transportation and deposition of soil particles from one place to another by water, wind or any other agent.</td>
</tr>
<tr>
<td>Gust</td>
<td>A sudden powerful rush of wind.</td>
</tr>
<tr>
<td>Leeward Surface</td>
<td>A surface away from where the wind is coming from.</td>
</tr>
<tr>
<td>Sand Ripples</td>
<td>It occurs when larger grains left after being transported by way of smaller grains and it forms perpendicular to wind direction.</td>
</tr>
<tr>
<td>Sediment</td>
<td>Refers to any fragmented material, transported or deposited by wind or any other natural agent.</td>
</tr>
<tr>
<td>Slip Face</td>
<td>Steeply sloping leeward surface of a sand dune also known as sand fall.</td>
</tr>
<tr>
<td>Surface Creep</td>
<td>The soil particles, which are too heavy and move along the surface by the impact of flowing water.</td>
</tr>
<tr>
<td>Threshold Velocity</td>
<td>It is defined as the minimum velocity required for initiating the movement of a particle of a particular size. In general, the larger the particle, the higher the threshold velocity required to move it. Sometimes, this does not hold good when clay particles are involved in the detritions process. Clay particles have a general tendency to become cohesively bonded to each other. This aggregation results in the clumping of several particles into a mass of much larger size. As a result, the threshold velocity required to erode clay is as great as the wind speed required to move grains of sand. Silt is usually the easiest type of particle to be readily eroded by wind.</td>
</tr>
<tr>
<td>Wind Blown Dust</td>
<td>Sand particles generally do not travel very far in the wind, but smaller sized fragments can be suspended in the wind for much larger distances.</td>
</tr>
</tbody>
</table>

### 2.10 SUGGESTED READING


2.11 MODEL ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

1) Causes of wind erosion
   - Dry period and absence of a protective cover on the ground.
   - Broad, flat or undulating topography over which wind can move unchecked.

Effects of wind erosion
   - Changes in soil texture resulting from attrition and winnowing.
   - Removal of top soil.
   - Scalding of the soil surface.
   - Exposure of root system of trees and shrubs.
   - Sand deposits.

2) Generally, the movement of soil by wind is a complex process. Soil blowing usually starts on exposed knolls or hilltops, tracks made by implements or animals and at the end of turn rows where excessive turning and cultivation have loosened the surface soil. Once initiation of soil movement starts from such sensitive points, the jumping soil grains severely abrade the surface. The abrasion breaks down the soil aggregates, clods, stable crusts and wears down vegetative residues and living
Soil Erosion

vegetative cover. The material detached from clods and crusts by abrasion may be either deposited on the leeward side of the field or carried away, depending upon the fineness of the soil and wind velocity.

Following processes are involved in wind erosion:

a. Initiation and Movement

b. Transportation
   - Suspension
   - Saltation
   - Surface creep

c. Deposition

3) Deposition could occur when the wind velocity gets reduced due to surface obstructions or other natural causes. Wind can deposit sediment when its velocity decreases to a point where the particles can no longer be transported.

4) Sand dunes are formed in environments that favour the deposition of sand. Deposition occurs in areas where a pocket of slower moving air is formed next to much faster moving air. Such pockets typically are formed behind obstacles like the leeward sides of slopes. As the fast air slides over the calm zone, saltating grains fall out of the air stream and accumulate on the ground surface.

Check Your Progress 2

1) The factors responsible for wind erosion are:

   **Climatic Conditions:** The climatic factors that influence wind erosion are the characteristics of the wind itself in addition to precipitation, humidity and temperature. The climatic factors influence the soil moisture status, which in turn influences the susceptibility of the soil to erosion by wind. The velocity of the prevailing wind is the dominating factor affecting soil erosion in dryland areas. Wind velocity at the ground surface is the most determining factor affecting soil erosion.

   **Surface Roughness:** A rough ground surface is a low height barrier either formed through mechanical manipulation of the surface soil or by raising the obstructions protruding out of the ground surface.

   **Vegetative Cover:** Various kinds of vegetative covers such as crop stubble and residue, and bio-mulching material efficiently protect the soil surface from eroding energies of wind by reducing the wind velocity at the ground surface.

2) Moving winds, which are turbulent in nature, impart vibration energy to initiate the movement of soil particles by dislodging. In usual sense, turbulent winds produce gusts with eddies and cross-currents that are responsible for lifting and transportation of the soil grains.

   A rough ground surface reduces the abrasion and attrition, the normal build-up and concentration of eroding material downwind. Roughening the land surface is not always effective in reducing wind erosion, though it slows down the wind velocity and tends to trap saltating soil particles.
3) When the land is exposed directly to the wind in the absence of vegetative cover on the ground surface, it is vulnerable to erosion by wind. Biomass and plant covers not only reduce wind velocity at the surface but also dissipate the erosive force exerted by the wind. Efficiency of such covers depends on the quality, quantity and orientation of the residue in relation to the prevailing wind direction. In addition, vegetation modifies local climate in favour of further regeneration of plants and enhances the relative humidity of the air. Leeward side of vegetative strips acts as shelter zone where deposition occurs due to reduction in wind velocity. In this way, vegetation checks erosion and helps in deposition.

Check Your Progress 3

1) Field sand traps and laboratory tunnels are the methods employed for measurement of wind erosion in the field and the laboratory, respectively.

Field Sand Traps

**Horizontal sand trap:** It consists of trough sets in the ground with their top level with the surface and kept parallel to the wind direction. The trap may sometimes be divided into several sections so that saltating soil grains fall into different compartments according to their bouncing amplitude. In this technique, the weight of the eroded material is recorded automatically.

2) The equation used for wind erosion is given as:

\[ W_E = f(IKCLV) \]

Where,

- \( W_E \) = average annual soil loss, tones/ha/yr;
- \( I \) = soil erodibility index is the potential for soil loss from a wide, level, unsheltered and isolated fields with a bare, smooth, loose and uncrusted surface. Soil erodibility is based on soil surface texture and calcium carbonate content;
- \( K \) = ridge roughness factor is a measure of the effect of ridges formed by tillage and planting implements. The ridge roughness is based on ridge spacing, height and erosive wind directions in relation to the ridge direction;
- \( C \) = climatic factor is a measure of the erosive potential of the wind speed and surface moisture at a given location;
- \( L \) = unsheltered distance is the distance across an erodible field, measured along the prevailing wind direction. This distance is measured beginning at a stable border on the upwind side and continuing downward to the non-erodible or stable area, or to the downwind edge of the area being evaluated; and
- \( V \) = Vegetative cover factor accounts for the kind, amount and orientation of growing plants or plant residue on the soil surface.